POWER

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Waiting

DID you ever notice what a small proportion of the time one spends in doing really productive work, in actually making the thing that counts, and what a large proportion in getting at it?

How many hours a day do you spend in getting to and from your work at morning, noon and night, and what proportion is it of the hours that you actually work?

There would be quite a saving in this time overhead, would there not, if men would work longer each day and fewer days; that is, if they were kept at school longer and retired earlier, if they contributed their life's share to the world's work in fewer, longer days in their middle life?

The investment overhead would be reduced, too. The number of mills, factories, machines, etc., necessary to do the world's work could be reduced one-fifth if they ran ten hours instead of eight, one-third if they ran twelve hours.

Of the time that it takes you to get from your home to your work and back again, what proportion do you spend in actually moving toward your objective and what proportion in waiting for trains, boats, trolleys; for somebody else to get ready to move?

Measured by the collective worth of the time of the people that they carry, what an investment in the improvement of the transportation facilities of a community would be warranted.

One man will buckle down to a job and concentrate on it. Every movement means something toward the finished product. His tools are ready to his hand, and when he finishes with one he puts it where he will want it next. Another man will use more time fitting and fussing and puttering, starting wrong and backing up to do it over again and hunting for misplaced tools and parts, than it would take a straightforward worker to do the job twice over.

All men are not born equal, but there is one thing of which all have an equal share, and that is time. The man who unnecessarily makes another wait and robs him of his time, does him as real a wrong as robbing him of his money; and the man who is thrifty with his time and wise in its investment, will not want.

F. R. Low

Central Heat and Power Plant for Group of Office Buildings

Plant Located in Residential Section of City—Supplies Light, Heat, Power and Other Services—Main Units, Poppet-Valve Engines Direct-Connected to Generator—Boilers Fired with Underfeed Stokers—Ashes Handled by Steam Jet Conveyor

BY GEORGE C. STIERHOFF

THE large central power stations present excellent ideas as to design and construction, but the size that interests a large number of readers is the plant from about 500 to 1,000 kw., as that covers a great range of large office buildings and small industrial plants.

The plant described herewith is operating in a city where central-station power is comparatively cheap and where it is used by the greater portion of small industrial plants, where power is their greatest requisite. This plant operates at good efficiency by utilizing the low-pressure exhaust from the main units in a vacuum heating system, and a hot-water generator.

During 1921 The Maryland Casualty Company completed a group of new office buildings on a site consisting of twenty-five acres in the Roland Park section of the City of Baltimore. In addition to the new office buildings the company contemplates a community housing project which they will serve with cheap light and heat from their power plant.

As the site chosen is in the residential section of the city, it was considered advisable to have separate buildings, and these have been grouped to suit the topography of the land, taking into consideration the best approach to the site.

The buildings are of reinforced concrete, fireproof construction, on concrete foundations. The exteriors are of red brick with the modern Italian style of architecture. The present group consists of five buildings: The administration building, 320x200 ft., in the form of the letter H; the clubhouse, 262x82 ft.; printing shop, 120x60 ft.; garage, 120x55 ft.; power house, 102x52 ft. The total floor space is 277,000 square feet.

The power house is at the rear end of the industrial group. The building shown in Fig. 1 is of red face brick and has a floor space of about 9,000 sq.ft. It is well lighted and ventilated. The inside walls are of white brick and the floors are red tile. The boiler and pump rooms are 8 ft. below the level of the engine room. There is a coal vault 32x52 ft., with a capacity of about 200 tons, which extends out from the boiler room, allowing the coal to be delivered from the service roadway by gravity. It is delivered to the plant in trucks, and a check on the weight is made on a platform scale. A check is again made on the consumption by delivering the coal from the vault to the boiler in small trucks which hold a standard weight; the number of trucks delivered is recorded.

The generating equipment consists of one 13x18-in. Lentz steam engine direct-connected to a 100-kw. 3-wire 250-volt direct-current generator operating at 200 r.p.m., and one 17x21-in. engine of the same type direct-connected to a 150-kw. generator and operating at the same speed. A foundation has been provided for a future unit of 150 kw. On the steam loop to each

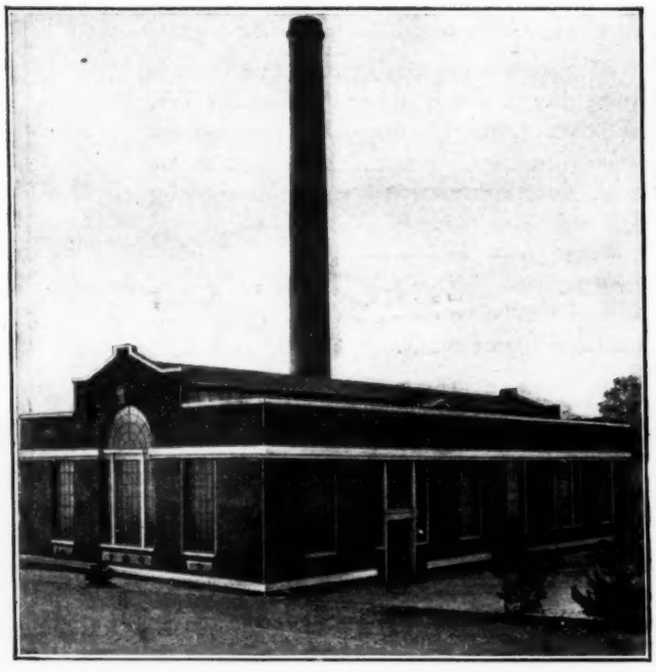


FIG. 1—POWER PLANT, MARYLAND CASUALTY CO.

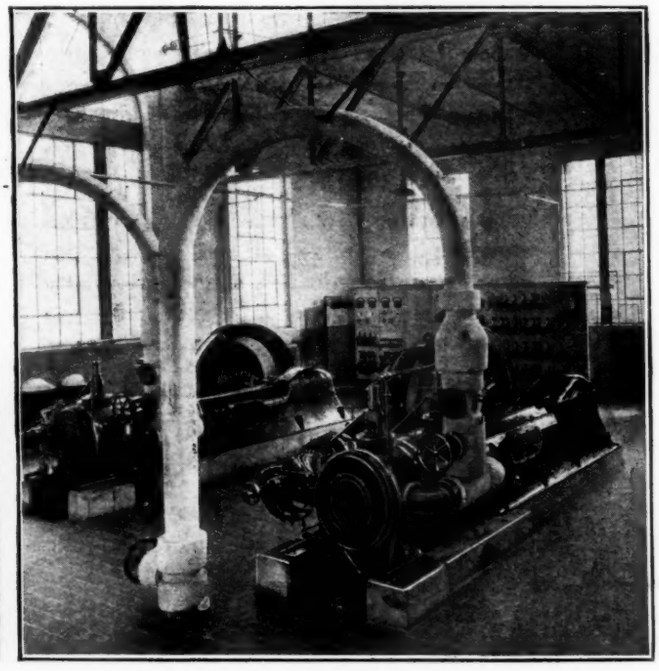


FIG. 2—VIEW OF ENGINE ROOM

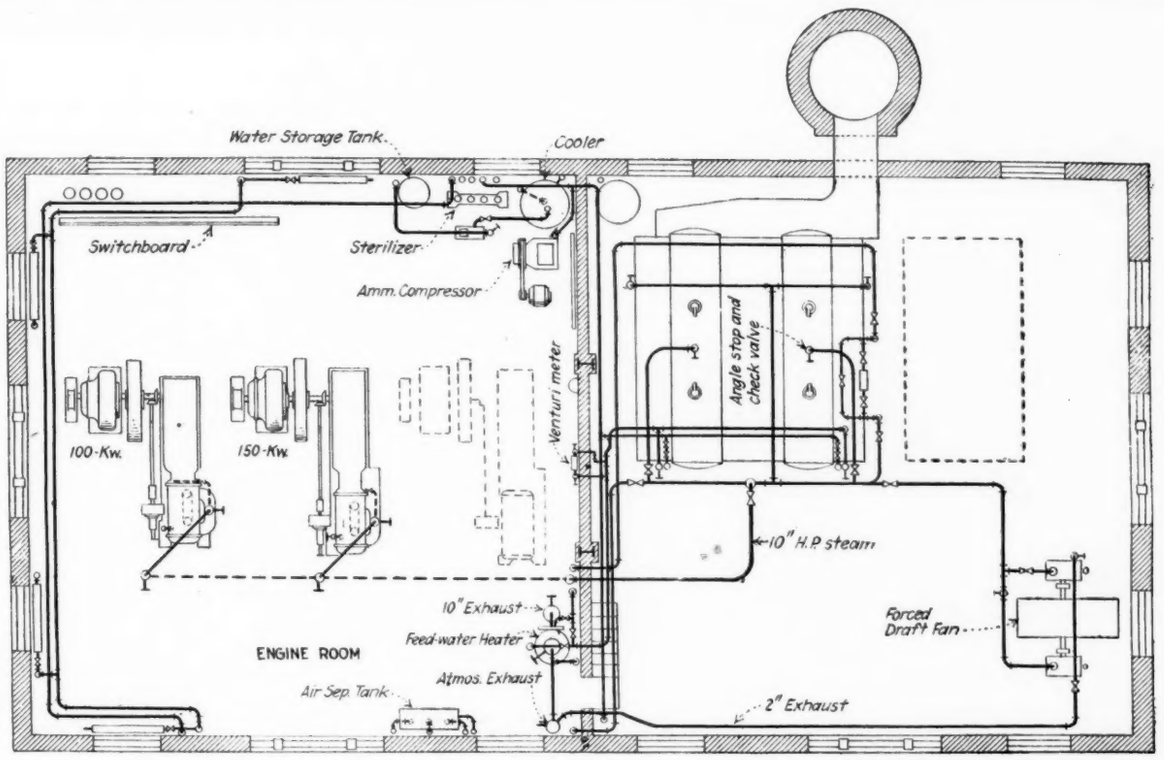


FIG. 3—PLAN OF ENGINE AND BOILER ROOM

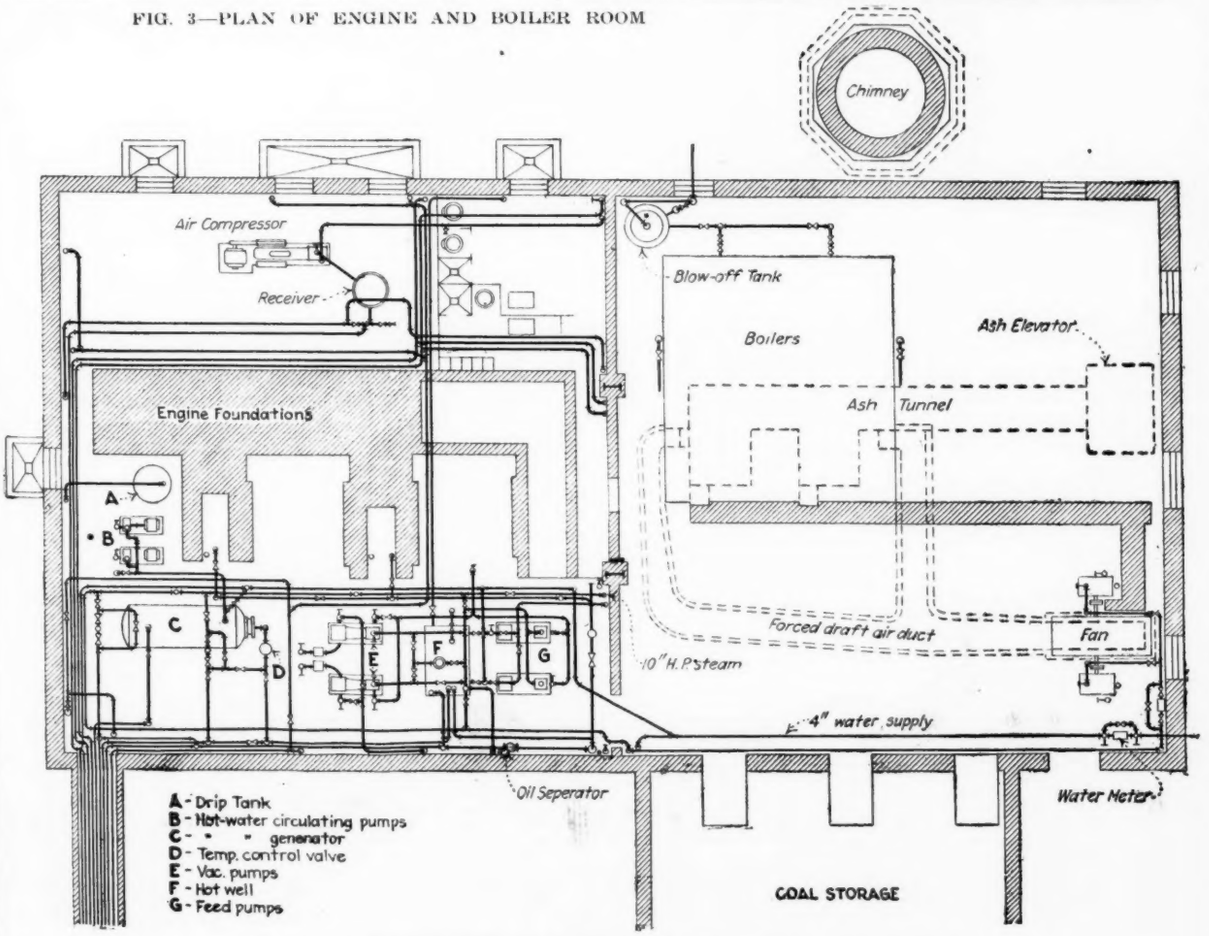


FIG. 4—ARRANGEMENT OF AUXILIARY EQUIPMENT AND PIPING

engine an automatic stop valve is placed between the main stop valve and the separator. Conduit slots 10x10 in. are provided in the foundation under each of the generators and carry the conduits to the switchboard located in the corner of the engine room, as shown in Fig. 2. The board is equipped with the necessary indicating and recording instruments. An additional panel at one end of the board is fitted with pressure, vacuum and other gages essential to the operation of the plant.

The boiler plant consists of two horizontal water-tube boilers, each rated at 2,530 sq.ft. heating surface. They are designed for 175 lb. pressure but are operated at 125 lb. per inch normal working pressure. They

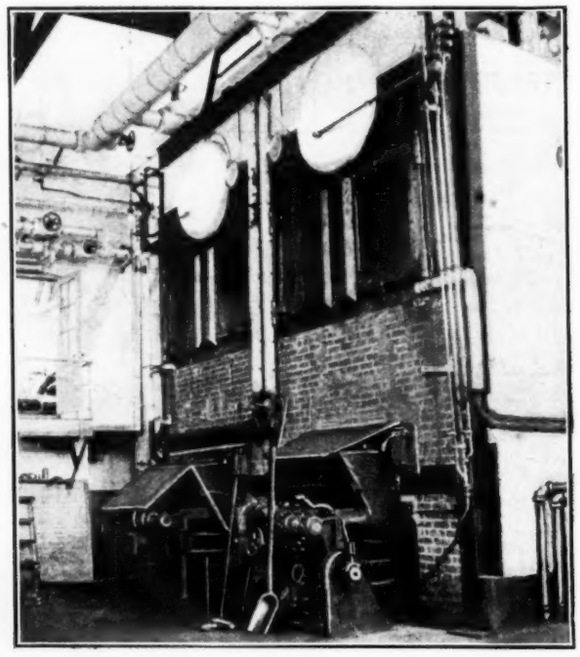


FIG. 5—FRONT VIEW OF BOILERS AND STOKERS

are fired by 4-retort underfeed stokers driven by a small steam engine. Each boiler is equipped with a 4-element soot blower. In addition to the draft supplied by the radial brick chimney 125 ft. in height and 6 ft. inside diameter at the top, forced-draft air is supplied by a Sirrocco type blower direct-connected to a vertical steam engine. The forced draft is delivered under the boilers through air ducts built under the floor, as shown in Fig. 4.

In addition to the regular stop valve and gages each boiler is equipped with CO_2 recorder, pyrometer and draft gage to enable the engineer to keep a close check on the efficiency of the plant. The fuel generally used, is bituminous coal from West Virginia.

The ashes are removed from the ashpits into a steam-jet conveyor and delivered to a larger hopper at the rear of the building. The ashes are passed directly from the hopper into carts. The pumping equipment is in the engine-room basement and includes two duplex boiler-feed pumps, two simplex vacuum pumps for the heating system and two motor-driven centrifugal circulating pumps rated at 80 gal. per min. for circulating the hot water through the different buildings. The hot water is supplied by an exhaust steam heater or generator of 1,400 gal. capacity, the steam to which is regulated by a temperature control valve. All condensation from the heating system is returned to a 4-ft. by 4-ft. 6-in. by 6-ft. receiver located in the pumproom.

The piping system is liberally supplied with the necessary stop valves, strainers, pressure and temperature control valves, traps and separators. Large-radius pipe bends are used where possible, and ample provision is made for expansion and contraction. The piping is also equipped with bypasses at different points to facilitate repairs. The piping is wrought iron throughout.

The exhaust from the main generating units passes directly to a 10-in. header and then through an oil separator to the vacuum heating system of the buildings, which has a total radiation surface of over 22,000 sq.ft. In addition to the exhaust from the engines a connection is taken off the high-pressure steam main through a pressure-regulating valve to the main heating header. This provides any additional steam necessary during the most severe weather. The vacuum is maintained by two vacuum pumps connected through an air separating tank located in the engine room to the condensation receiver in the pumproom. The main 10-in. exhaust header is also connected to closed feed-water heater in the engine room and to the hot-water generator.

The buildings are all equipped with a compressed-air system, the air being supplied by a single-stage air compressor driven by a 15-hp. motor and discharging directly to a 3-ft. by 5-ft. 6-in. receiver.

There are two 5-ton motor-driven ammonia refrigerating machines, one in the power house and one in the clubhouse. The machine in the power house generates all the ice water used about the buildings, while the one in the clubhouse is used in connection with the cold storage in the restaurant, and it also has a bypass into the drinking-water line.

DATA ON MECHANICAL EQUIPMENT OF THE MARYLAND CASUALTY CO., POWER PLANT.

Boilers (2) hor. water tube	Erie City Iron Works
Water-heating surface	2,530 sq.ft.
Operating pressure, lb. gage	125
Designed pressure, lb. gage	175
Stokers (2) underfeed, four-retort	American Engineering Co.
Drive, vertical steam engine	Troy Engine & Machine Co.
Grate Area, sq.ft.	56
Ratio, waterheating surface to grate area	45
Fan, 1 forced-draft	American Blower Co.
Drive, vertical steam engine	Troy Engine & Machine Co.
Stack, radial brick 6 x 125 ft.	American Chimney Corp.
Ash removal-steam jet conveyor	American Conveyor Corp.
Feed pumps, 2 duplex steam	Worthington Machine Corp.
Soot blowers	Diamond Power Specialty Corp.
Differential draft gages	Haas Gage Co.
Draft gage	Lewis M. Ellison
Safety valves	Consolidated Safety Valve Co.
Stop and non-return valves	Schutte & Koerting Co.
Blowdown valves	Chapman Valve Mfg. Co.
Damper control	Mason Regulator Co.
Generator—One—100-kw. 250-volt	Crocker-Wheeler Co.
Drive 13 x 18-in. Lentz steam engine—200 r.p.m.	Erie City Iron Works
Generator one—150-kw. 250 volt	Crocker-Wheeler Co.
Drive 17 x 21-in. Lentz steam engine, 200 r.p.m.	Erie City Iron Works
Pressure and temp. at throttle, 125 lb. saturated.	
Guaranteed performance 20.2 lb. per 1 hp. full load.	
Vacuum pumps, 2 simplex steam	American Pump Co.
Hot water generator 1,400-gal.	American Feed Water Corp.
Circulating pumps 2 centrifugal	Goulds Mfg. Co.
Drive, 2 and 5-hp. direct-current motors	General Electric Co.
Feed-water heater, closed	American Feed Water Corp.
Feed-water measurement, venturi meter	Builders Iron Foundry
Air compressor 1 single-stage	Ingersoll-Rand Co.
Drive 15-hp. motor	General Electric Co.
Refrigerating machines, 2 ammonia	Brunswick Ref. Co.
Drive 15-hp. motor	General Electric Co.
Reducing valves	Crane Co.
Low-pressure valves	Crane Co.
Low-pressure valves	Chapman Valve Mfg. Co.
Traps	V. D. Anderson Co.
Automatic engine stop "Falls pat"	Jenkins Machine Co.
Water filters (2)	American Sterilizer Co.
Heat regulation, thermostatic control	Cuyler & Mohler
Plumbing and heating contractor	Wm. Hellbach
Service pump (1) triplex	Goulds Mfg. Co.
Drive 5-hp. motor	Crocker-Wheeler Co.
Pipe covering	Philip Carey Co.
Oil separator	V. D. Anderson Co.
Direct return traps	Crane Co.
Piping (wrought iron) contractor	H. E. Crook Co.

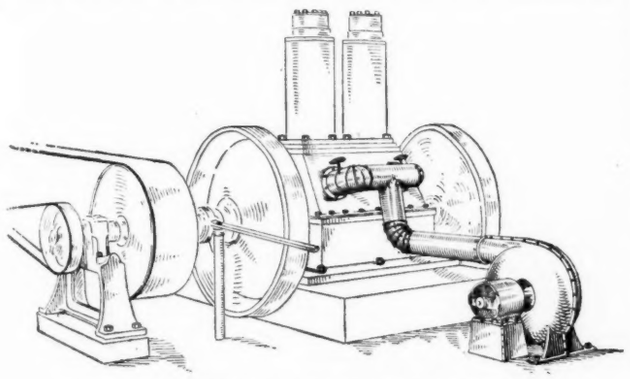
Increasing the Output of a Semi-Diesel Engine

By S. M. Howe

An oil engine's horsepower rating is usually set at the point where its efficiency is maximum at sea level. This will in most cases leave an overloaded margin of at least 20 per cent. When an engine is installed at a high altitude its sea-level output will not be obtained without alterations in its construction.

This lowered output at high altitudes was met with in a mine plant in New Mexico where two 100-hp. semi-Diesel engines were installed. These engines were rated up to about what they could do at sea level, and when installed at an altitude of about 5,000 ft., where the atmospheric pressure is 12.1 lb. per sq.in., they would not carry their rated load.

As all know, the amount of fuel that can be burned in any kind of oil engine depends upon the amount of



BLOWER INCREASES AIR-SUCTION PRESSURE

air that is trapped in the cylinder when the exhaust and suction valves close, in the case of a two-stroke-cycle semi-Diesel when the piston covers the exhaust ports. If each particle of air could mix with just enough gas to burn completely, about 13 lb. of air would be required per pound of oil supplied to the engine, the exact amount depending upon the composition of the oil. It is impossible to cause this perfect mixing of the air and oil, so an excess of air must be supplied. This means that instead of 13 lb. of air being needed, at least 18 lb. is furnished to the engine per pound of oil and in case of a semi-Diesel about 26 lb. of air per pound of fuel.

At sea level, air at 60 deg. F. temperature will usually weigh 0.765 lb. per cu.ft. Above sea level, the air is less dense, its weight per cubic foot is less. If the same weight of air is to be used, a greater number of cubic feet must be supplied the engine. This means that either the engine must be run faster to give more cylinder charges per minute, or the air entering the cylinder must be made denser, that is, it must weigh more per cubic foot than the atmospheric air.

Increasing the engine speed is not possible in case of direct-connected generating units. Even belted engines may not be speeded up to any considerable extent, for the inertia effect of the reciprocating parts, which have been designed for a definite speed, may become dangerous. At all events the engine will pound and combustion may be faulty by reason of the higher number of cycles per minute. The plan of increasing the air density is the only feasible one.

The plant in question adopted this idea and secured two motor-driven centrifugal pressure blowers designed to give an 11-in. discharge pressure. Each blower was set as shown in the illustration with a branch of the discharge pipe leading to each crankcase air-suction-valve opening.

In semi-Diesel engines, there is usually a drop in pressure of about two pounds as the air going to the crankcase passes through the suction line and valve. This, with an atmospheric pressure of 12.1 lb., will give a crankcase pressure of about ten pounds absolute. The blower was able to eliminate practically the drop through the air valve as well as increase the air pressure by 12 oz., giving a crankcase suction pressure of close to 12.7 lb. absolute. The weight of air put into the crankcase and finally into the engine cylinder, was increased in direct ratio to the increase in absolute pressure, or about 12 per cent. The indicated horsepower of the engine was thus increased a like amount, making the brake horsepower increase almost 20 per cent. Even deducting the power required by the blower, the net gain was about 15 hp. per engine; in addition the operation was improved by reason of the better combustion and scavenging. However, the blower arrangement did not enable the engines to carry their rated load.

The exhaust lines from the two cylinders of each engine led into a common exhaust pot having a 10-in. discharge pipe. As an experiment the exhaust pot of one engine was removed and a makeshift sheet-steel exhaust pipe connected to each cylinder exhaust outlet. An improvement in the engine's behavior was noticed immediately. Continuing the experiment, the exhaust pipe was lengthened and shortened at different times. The length that seemed to allow the engine to carry the greatest load was made the permanent exhaust-pipe length. Strange to say, this was not the shortest length by any means; it was found that exhausting in the room—that is, with no pipe at all—the engine could not carry as heavy a load as when the exhaust pipe was made 14 ft. 10 in. long. A longer pipe made the engine labor under less than three-quarters load. Why this was true I do not attempt to explain. With the correct exhaust length determined, the blower was disconnected, but the engine capacity dropped, so the blower was replaced.

The plan of using a blower introduces extra equipment and is probably justified only in case of high altitudes. On the other hand, experimenting to find the correct exhaust-pipe length is easily carried on and may result in increased power and reduced fuel bills, no matter where the plant is located.

The straight repulsion-type of single-phase motor may be reversed by shifting the position of the brushes from one side of the axis of the field poles to the other. The correct running position of the brushes is generally about 12 to 15 electrical degrees to the right or left of the field-pole axis. In the compensated type of repulsion motor, if the brushes are shifted only 12 to 15 electrical degrees to the right or left of the field-pole axis, to reverse the direction of rotation, it will also be necessary to interchange the leads of the compensating winding at the brushes. If the brushes are shifted approximately 210 electrical deg. to reverse the direction of rotation, then the compensating leads will not need to be reversed.

The Exposed Stem Correction for Mercury Thermometers

Measuring Temperature of Exposed Stem — Ordinary Formula for Correction — Logarithmic Chart for Ordinary Formula — Direct Formula for Correction — Method of Constructing Large-Scale Chart for Direct Formula

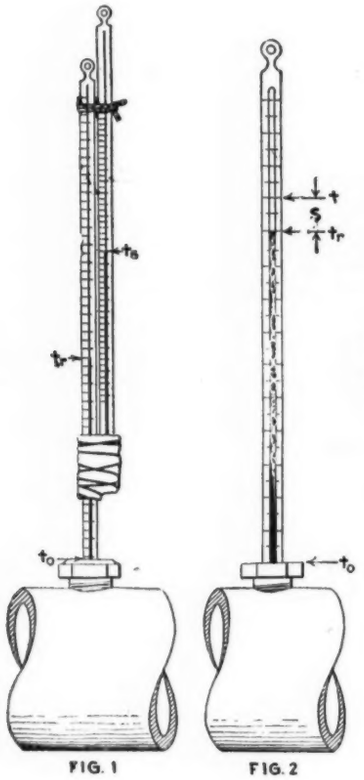
By WM. L. DeBAUFRE

Chairman Mechanical Engineering Department, University of Nebraska, and Consulting Engineer for U. S. Bureau of Mines

WHEN the stem of a mercury thermometer is exposed to a temperature different from that of the medium in which the bulb is immersed, the indication of the thermometer is either too high or too low, depending upon whether the stem temperature is above or below that of the bulb. For certain permanent installations in a power plant it is an advantage to use thermometers graduated for partial immersion. For general purposes, however, and particularly for accurate test work it is considered preferable to graduate the thermometer for total immersion and then to apply stem corrections for the various degrees of exposure to which the thermometer may be subjected.

For accurately determining the stem correction, special auxiliary thermometers have been developed, but in most engineering measurements the stem temperature may be determined with sufficient accuracy by means of an ordinary thermometer tied to the stem of the main thermometer as shown in Fig. 1. It is considered desirable to cover the bulb of the stem thermometer to protect it from radiation. The variation in temperature along the stem of the main thermometer is not so great as might be expected, so that fairly accurate indications of the mean stem temperature are obtained if the bulb of the auxiliary thermometer is located just below the middle point of the exposed mercury column.

The error with an exposed stem is due to the temperature of both the glass stem and the mercury therein



FIGS. 1 AND 2—THERMOMETER READINGS

Fig. 1—Measuring stem temperature by an auxiliary thermometer. Fig. 2—Explanation of symbols used in discussing correction of error due to exposed mercury column.

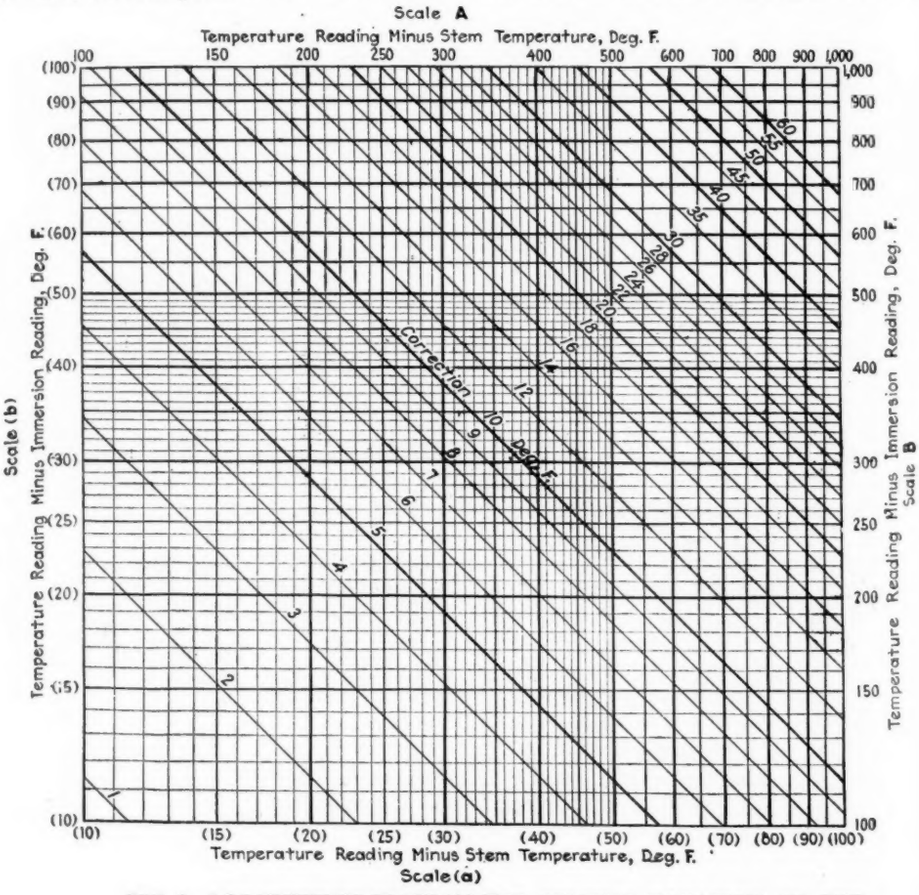

Scale A
Temperature Reading Minus Stem Temperature, Deg. F.
Scale (b)
Temperature Reading Minus Immersion Reading, Deg. F.
Correction, Deg. F.
Scale B
Temperature Reading Minus Immersion Reading, Deg. F.
Temperature Reading Minus Stem Temperature, Deg. F.
Scale (a)

FIG. 3—LOGARITHMIC DIAGRAM FOR SOLVING EQUATION (2) FOR STEM CORRECTION OF THERMOMETERS

Where scales *A* and *B* are used, read the corrections as given. Where scales *A* and *b* or *B* and *a* are used, divide the indicated corrections by 10. Where scales *a* and *b* are used, divide the indicated corrections by 100. If the correction is large it should be considered as a first approximation to be added to the original differences before entering the diagram for the final correction.

being at, say, a lower temperature than that of the bulb. The amount of the error is dependent upon the coefficients of expansion of both the glass and the mercury. For ordinary thermometer tubing the mean coefficient of relative expansion of mercury in glass may be taken as 0.000158 per degree C., or 0.000088 per degree F.

Referring to Fig. 2, let t represent the true temperature of the bulb. Then the mercury would rise to the point t degrees were the stem at the same temperature as the bulb. If, however, the thermometer is immersed only to the point t_o degrees, and if the mean temperature of the exposed stem is t_s instead of t, then the exposed mercury column would be shortened a distance S equal to the product of its original length $(t - t_o)$

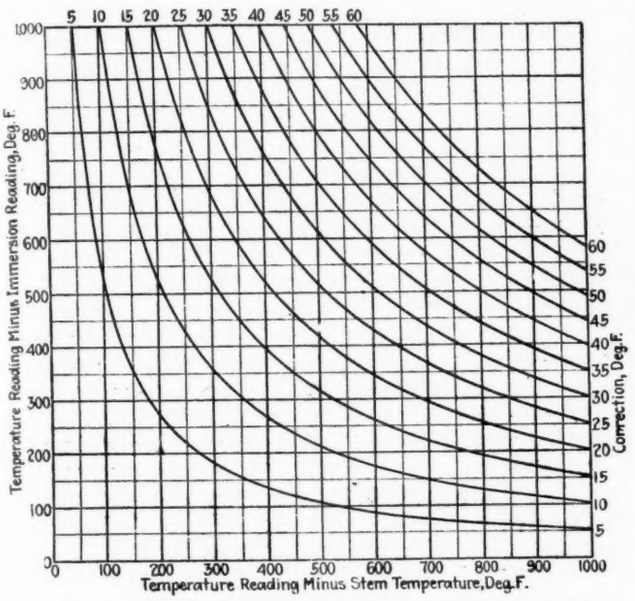


FIG. 4—CURVES FOR GETTING THE EXACT CORRECTION IN ONE OPERATION

For practical use this diagram should be replotted on a much larger scale as explained in the article.

times its difference in temperature $(t - t_s)$, times the mean coefficient of relative expansion d, or

$$S = d(t - t_s)\ (t - t_o) \qquad (1)$$

In attempting to apply this formula, we find that the observed reading t_r is known and that we wish to determine the true temperature t by means of the correction S. It has been customary to modify formula (1) to

$$S = d(t_r - t_s)\ (t_r - t_o) \qquad (2)$$

by substituting the temperature reading t_r for the true temperature t. The formula is then approximate only. It has also been customary when the correction was large, to recalculate it by substituting the corrected temperature reading. For example, let the thermometer reading be $t_r = 415.4$ deg. F. when immersed to $t_o = 200$ deg. F. and having a stem temperature of $t_s = 102$ deg. F. Substituting in (2), we get

$$S = 0.000088\ (415.4 - 102)\ (415.4 - 200)$$
$$= 0.000088 \times 313.4 \times 215.4$$
$$= 5.9 \text{ deg. F.}$$

The first approximation to the true temperature is, then, 415.4 + 5.9 = 421.3 deg. F. Substituting $t_r = 421.3$ deg. F., we have

$$S = 0.000088\ (421.3 - 102)\ (421.3 - 200)$$
$$= 6.2 \text{ degrees}$$

A closer approximation to the true temperature is $t = 415.4 + 6.2 = 421.6$ deg. F. The difference between the approximate correction and the true correction is even more noticeable at higher temperatures and greater exposures.

To facilitate the solution of this formula, Fig. 3 was prepared. [This diagram and the comments on its use have been added by the editor.] This chart is entered with $t_r - t_s$ on the horizontal scale and $t_r - t_o$ on the vertical, the correction being read from the 45-deg. lines. Since this diagram is based on formula (2), it does not give the theoretically exact correction in one operation. For example, in the problem just solved by computation, scale A is first entered with 313.4, and scale B with 215.4. This gives 5.9 for the first approximation of the correction. Adding this to each of the two differences gives 319.3 for scale A, and 221.3 for scale B. When these corrected values are applied to the diagram, 6.2 is obtained as the second approximation of the correction. Further approximations are unnecessary in this case, while in some cases the first approximation will be sufficiently accurate. One who makes a large number of such corrections will soon learn to tell by inspection whether it is worth while to make a second or third approximation in any particular case.

To avoid the necessity of repeated substitutions to obtain the true correction, formula (1) has been modified by substituting $(t_r + S)$ for t. The formula then becomes

$$S = d(t_r + S - t_s)\ (t_r + S - t_o)$$

Solving for S, we have

$$S = \frac{d(t_r - t_s)\ (t_r - t_o)}{1 - d[(t_r - t_s) + (t_r - t_o)]} \qquad (3)$$

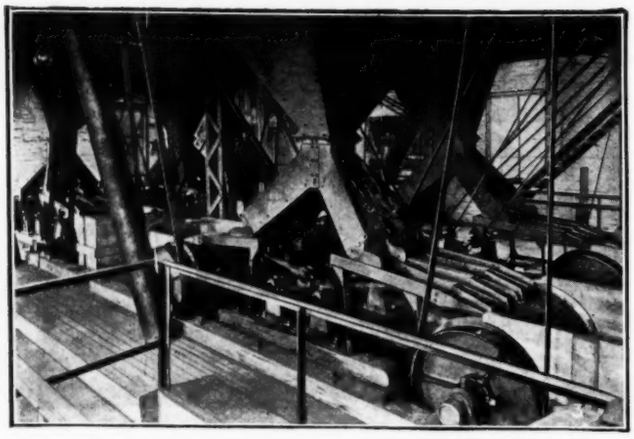
In formula (3) a term involving dS^2 has been dropped. This quantity is very small indeed, so that practically no error results from eliminating it. Substituting in (3), we obtain the true correction at once. For example, in the problem just given it is

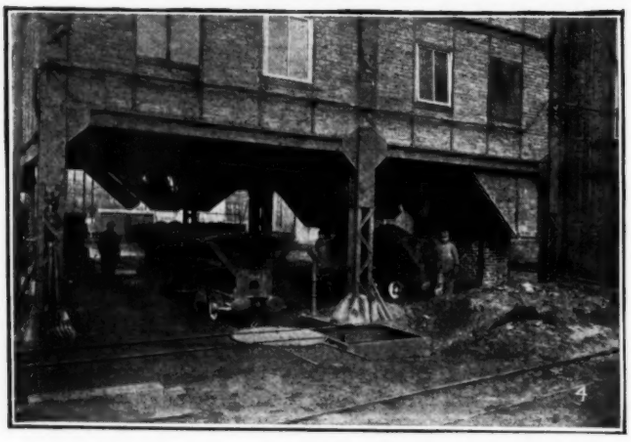
$$S = \frac{0.000088\ (415.4 - 102)\ (415.4 - 200)}{1 - 0.000088\ [(415.4 - 102) + (415.4 - 200)]}$$
$$= 6.2 \text{ deg.}$$

The true correction may also be obtained by means of a set of curves such as shown in Fig. 4, if these are replotted, as will now be described, to a sufficiently large scale. Assume, for example, that we wish to plot the curve corresponding to a temperature correction (S) of 15 deg. F. We first select a number of values of the temperature reading minus the stem temperature, $(t_r - t_s)$ as in the first column of the table. Then the value of the true temperature minus the stem temperature is evidently 15 deg. greater, as shown by $(t - t_s)$ in the second column. By substituting the figures in the second column in formula (1), we can solve for $(t - t_o)$ as given in the third column. Since the temperature read must be 15 deg. less than the true temperature, the values of $(t_r - t_s)$ in the fourth column must be 15 deg. less than the values in the third column. The first and fourth columns contain the co-ordinates of the curve in Fig. 4 for 15 deg. F. correction. While Fig. 4 is necessarily drawn to too small a scale to determine the correction accurately, these curves show how large the stem correction may become under certain conditions.

ILLUSTRATING METHOD OF COMPUTING CURVES OF FIG. 4

$(t_r - t_s)$	$(t - t_s)$	$(t - t_o)$	$(t_r - t_o)$
200	215	792.8	777.8
300	315	541.1	526.1
400	415	410.7	395.7
500	515	331.0	316.0
600	615	277.1	262.1
700	715	238.4	223.4
800	815	209.1	194.1
900	915	186.3	171.3
1,000	1,015	167.9	152.9





FIGS. 1 TO 4—SHOW PROGRESS THROUGH SEPARATION PLANT

Recovers Fuel from Slag and Ashes

By means of strong magnets acting on the ferric acids to which the silicates and lime adhere, the slag is separated from the combustible.

BY F. A. BRACKMANN

THE abnormal conditions prevailing in Germany during the last few years have provided a strong stimulus to save fuel, and increased interest has been taken in different systems for the extraction of combustible matter from ashes and similar residues. The flotation system was the first introduced, and various types have been placed on the market. They work on the principle that coke and slag have different specific gravities. The gravity varies according to the quality of the fuel, and to the degree of combustion.

Sometimes there is hardly any difference in the gravity of slag and coke, and much of the latter sinks with the slag, which causes considerable losses of fuel. Unburned coal also sinks and is removed with the slag. This not only constitutes a loss of fuel, but as the slag is extensively used in the manufacture of cement bricks lately, and as any coal mixed with it disintegrates after a time, the latter is detrimental to the quality of the bricks. These deficiencies of the wet process have considerably assisted the introduction of a dry-magnetic system of separation.

Over 80 Per Cent Combustible Recovered

This system, which is embodied in the patent plants put on the market by the Krupp-Gruson works lately, makes use of the fact that the iron pyrites in the coal changes into ferric oxide during combustion. The magnetic properties of these oxides, which are bound to the silicates and the lime in the slag, make it possible to separate the latter from the combustible matter by means of highly concentrated magnetic fields. The advantages of this process have quickly been realized, and a great number of plants are already working. Small coal, which is often contained in considerable quantity in the ashes, can also be recovered.

More than 80 per cent of the combustible matter mixed with the slag may thus be recovered. The plants are built in two types, movable and stationary, and in different sizes with a working capacity of one-quarter to twenty tons of residues per hour.

The residues are first tipped upon a grate of certain mesh, as shown in Fig. 1. Pieces that are too large to fall through are broken up with a hammer or run through a crusher. From the grate they pass through a sifting drum, Fig. 2, which separates them into two sizes. They are then passed to the separating machine, Fig. 3, where the slag on the one side and coal and coke on the other side fall into separate channels which may lead straight into cars or wagons below, as in Fig. 4.

The separating machine is, of course, the principal part of every unit. This machine consists mainly of a shaking feeder and a magnetic drum. Smaller plants are sometimes provided with elevators to haul up the

residues, and the grate and the sifting drum are substituted by a sieve which is fitted to the shaking feeder to separate the two sizes. Very large pieces are cast onto a moving band on the side, where they may be sorted by hand. The feeder delivers the residues onto the drum (Fig. 5), and the coal and coke, being non-magnetic, are thrown off, while the slag is held to it by

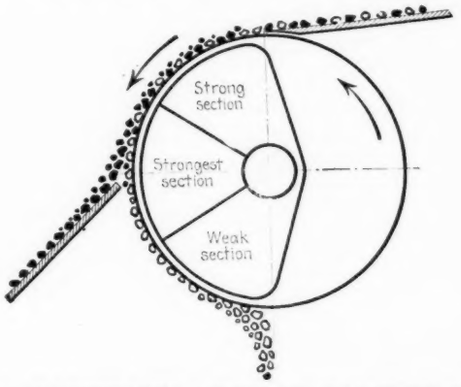


FIG. 5—ILLUSTRATES ACTION OF MAGNETIC DRUM.

the action of the magnet until it is carried past an iron sheet, which keeps the fuel and the slag apart after separation.

The magnet, which is stationary inside the revolving drum, consists of one, two or four fields according to the size of the machine. Corresponding to the number of fields the feeder has two or four narrow channels leading onto the drum. Each field is divided into three sections—a strong one on the upper side, the strongest in the middle to counteract the centrifugal force, and a weaker section below which carries the slag to the lowest part of the drum where it falls off. A drum of two fields separates about one ton an hour and needs about one kilowatt of continuous current. The machines are generally built for a voltage of 110 or 220. A small separating plant working up 1 to 1.25 tons an hour requires about 1.5 hp., and a plant of 2 to 2.5 tons about 2 hp., for the driving of the shaking feeder, the elevator and the revolving drum. The process promises to be an important factor in the efficiency of railways and industrial plants in Germany.

If a storage battery is in good condition, the specific gravity of all cells will rise and fall nearly the same amount, and between about the same hydrometer readings, as the battery is charged and discharged. This rise and fall is an excellent indication of the amount of charge in the battery and is used for that purpose. Within the limits of charge and discharge, over which a battery may be safely operated, the specific gravity varies directly with the amount of charge in the battery; that is, the variation of specific gravity when the battery is either charged or discharged, say one-half or one-third, is one-half or one-third the total change between full charge and full discharge, and similar values at other points.

On the first page of the article, "Swedish Boiler Operates at Pressure of 1,500 Pounds," in the Feb. 13 issue, reference is made to the use of 550 lb. at "the Philadelphia plant of the Ohio Power Co." "Philadelphia" is a typographical error. The actual location is Philo, Ohio.

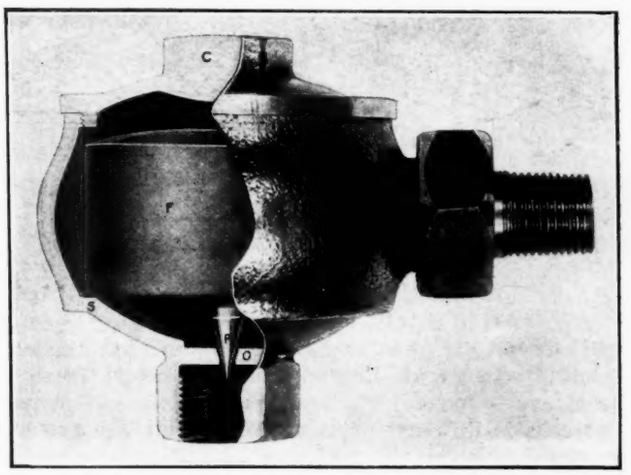
Simple Return Trap for Steam Heating Systems

The A & B return trap for low-pressure heating systems will pass both air and condensate from the radiator at any temperature without loss of steam. It is a combination of the float and thermal types and has but one moving part, the float *F*, which may contain either air or a volatile liquid.

When in the normal position, before steam has been admitted to the radiator, the float rests upon a number of shoulders *S*, cast integral with the body, with the tapered plug *P* held off its seat *O*, as shown. When steam is turned on, the cold air in the radiator is forced out through the trap. As soon as steam reaches the trap, the heat expands the air or volatile liquid within the float, causing the bottom of the float to bulge downward, thus closing the outlet with the tapered plug. As soon as the plug seats in the opening, the weight of the float is transferred from the seats *S* to the outlet *O*. This weight, bearing on the plug, is sufficient to prevent the escape of steam without causing the tapered plug to stick in the opening.

The outlet remains closed as long as only steam is in the trap. The float is buoyant, however, and lifts from its seat when enough water has collected in the bottom of the trap, thus opening the valve and allowing the water to escape.

The operation of this trap is not affected by the vacuum carried in the system, and the return end of the radiator can be at the same temperature as the supply end. It will be evident that the trap affords a means whereby the radiator is protected from freezing: When steam is shut off, the bottom of the float contracts and



A & B RETURN TRAP FOR HEATING SYSTEMS

When steam reaches the trap, the bottom of the float becomes convex, like the top, thus closing the outlet with the tapered plug and preventing the escape of steam.

returns to its normal position, lifting the plug from its seat and allowing water to drain from the radiator. (The float is then supported on shoulders *S* as before.) All these operations are automatic.

Made by the A & B Steam Specialties Co., 2701 Fulton St., Chicago, Ill., this trap is furnished in five sizes to serve radiation ranging from 100 to 3,000 sq.ft. Pipe sizes are ½, ¾ and 1 in. The body of the trap is cast in one piece from brass, while the float is made of a special bronze. Removal of the threaded cap *C* permits inspection and cleaning.

Locating Faults in Direct-Current Armatures—Testing for Grounds in Series Windings

Test Grounded Windings with Lamp Circuit—Testing to Locate Faulty Coils with Low-Reading Voltmeter—Cutting Grounded Coils out of the Winding

By B. A. BRIGGS

ONE of the first tests to be made on any electrical machine is one to determine if the windings are making metal-to-metal contact with the core or frame. Until it is known that the windings are insulated, all other tests are of little account, since one or more grounds in an armature winding may give the same effects as obtained for other faults. For example, if a test were made on a winding for short-circuits that had one coil with two or more turns grounded, this coil would give a low reading on a millivoltmeter, the same as if one or more turns were short-circuited. Where two coils in different parts of the winding are ground, it would have the effect of short-circuiting a group of coils, and if tests were made for short-circuits without first testing for grounds, indications of a group of coils being short-circuited might be obtained without knowing the real cause of the trouble.

Whether there is a ground in an armature winding can easily be determined by a test lamp. Connect one lead of the circuit onto the shaft or core and the other to the comutator, and if the lamp lights it is an indication of a ground. Absence of a light if the connections are properly made, shows the windings to be insulated. Lighting of the lamp is an indication of the ground in the winding, but it does not show which coil. If there were 100 coils in the winding, any one of them might be grounded, but the lamp would light irrespective of what commutator bar it might be connected to. In Fig. 1 assume that one or more turns of coil 10 are making contact with the core as at *X*. A lamp test circuit connected to any one of the commutator bars and the core will cause the lamp to light. If the lamp is connected to bar 9 and the core as indicated, there will be two complete circuits through the winding. One of these is through the lamp to the defect at *X* through part of coil 10 to bar 16 through coil 22 to *i'* and *i* through coils 9, 21, 8, 20, 7, etc., completing the circuit on bar 9 and to the negative side of the line. The other circuit is from *X* on coil 10 to bar 4 to *j* and *j'* through coils 23, 11, 24, 12, etc., until the circuit is completed on segment 9. These two circuits include all the coils in the winding. Because the coils have a low resistance, the lamp will burn brightly, which would be the case irrespective of what segment the test lead connected. Therefore, as previously mentioned the best that a lamp test will give is an indication that a ground exists in the winding, but the exact location of the defective coil must be determined by other means.

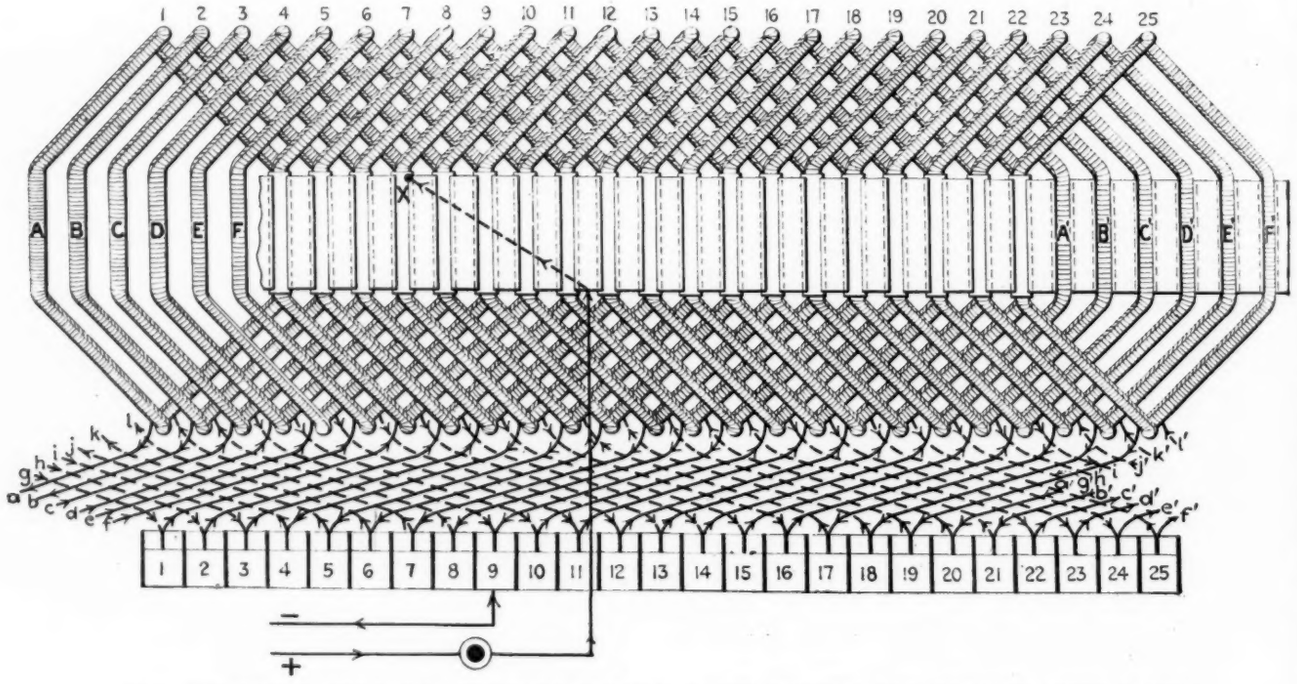


FIG. 1—CIRCUITS THROUGH ARMATURE WINDING WHEN TESTING FOR GROUNDS WITH LAMP

One of the best ways of locating a grounded coil is with a millivoltmeter, as shown in a previous article for the parallel winding (Oct. 31, 1922, issue). In the parallel winding a grounded coil showed up on the commutator by causing a low reading on the millivoltmeter at one location. In a series winding there will be as many locations on the commutator where a low reading

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may be obtained as there are pairs of poles in the machine. Two low readings will be obtained on a four-pole machine and three on a six-pole. These readings will vary somewhat in value, but the commutator segment where the lowest is obtained will be the nearest to the fault.

Fig. 2 shows how the test is made for a ground with a millivoltmeter. First a current is passed through the winding from an outside source, then one terminal of the millivoltmeter is connected to the armature core or shaft, and with the other terminal readings are taken on the commutator. Care should be exercised not to allow the millivoltmeter to be subjected to too high a voltage by having the current adjusted for too high a value. When the meter is connected to the core and segment 18, as in the figure, it will be the same as connecting the meter from *X* and segment 18. Just what takes place will be understood by tracing out part of the coil circuits. Starting from segment 7, one circuit is through coils 13, 25, 12 to segment 18. From segment 18 there are two paths for the current to get to coil 10. One of these is through the meter to the core and to *X*, as indicated by the arrowheads; the other is through coils 24, 11, 23 to segment 4 through coil 10; from here the circuit is through coils 22, 9, etc., until completed on segment 13. From this it is seen that the meter is connected across coils 24, 11, 23 and the part of coil 10 in series between segment 18 and the fault at *X*. Therefore it will read the voltage between these two points. If the meter lead is shifted from segment 18 to 17, then only coils 23 and part of coil 10 will be connected between the meter terminals and it will read less than when connected to segment 18. When the lead is on segment 16, the meter will be connected directly to that part of coil 10 between segment 16 and the defect at *X*. If the lead is placed on segment 15, this will be the equivalent of connecting the meter across coils 22, 9 and the part of coil 10 between the defect *X* and segment 16. Why this is so will be seen by following the circuit. The meter lead connected to the core is the same as connecting it to coil 10 at *X*. Now, to reach the meter lead on segment 15, the part of coil 10 between *X* and segment 16 must be passed through, also coils 22 and 9. Since two coils and part of a third are connected between the meter leads, when one of the latter is connected to segment 15, it will read higher than when connected to segment 16, when only part of coil 10 was connected between its terminals. Also, when connected to segment 17 the meter had a full coil and part of coil 10 connected between its terminals and will read higher than when on segment 16 and connected to part of coil 10. Therefore the low reading will be obtained from segment 16, which is the segment that the grounded coil connects to. The full and dotted arrows show the direction of the current through the meter when connected to segments 17 and 16, which is seen to be in opposite directions. Not only will the low reading be obtained on segment 16, but if a deflection of the needle is obtained it will be the reverse from that obtained on segment 17. Tracing the circuit through coil 10 will show why this is. Starting from segment 4 the circuit is through part of the coil to *X*; from here there are two paths to segment 15, one through the core and meter and the other through the coil. This gives a flow through the meter in a reverse direction to that obtained on segment 17 and will cause the needle to be deflected backward.

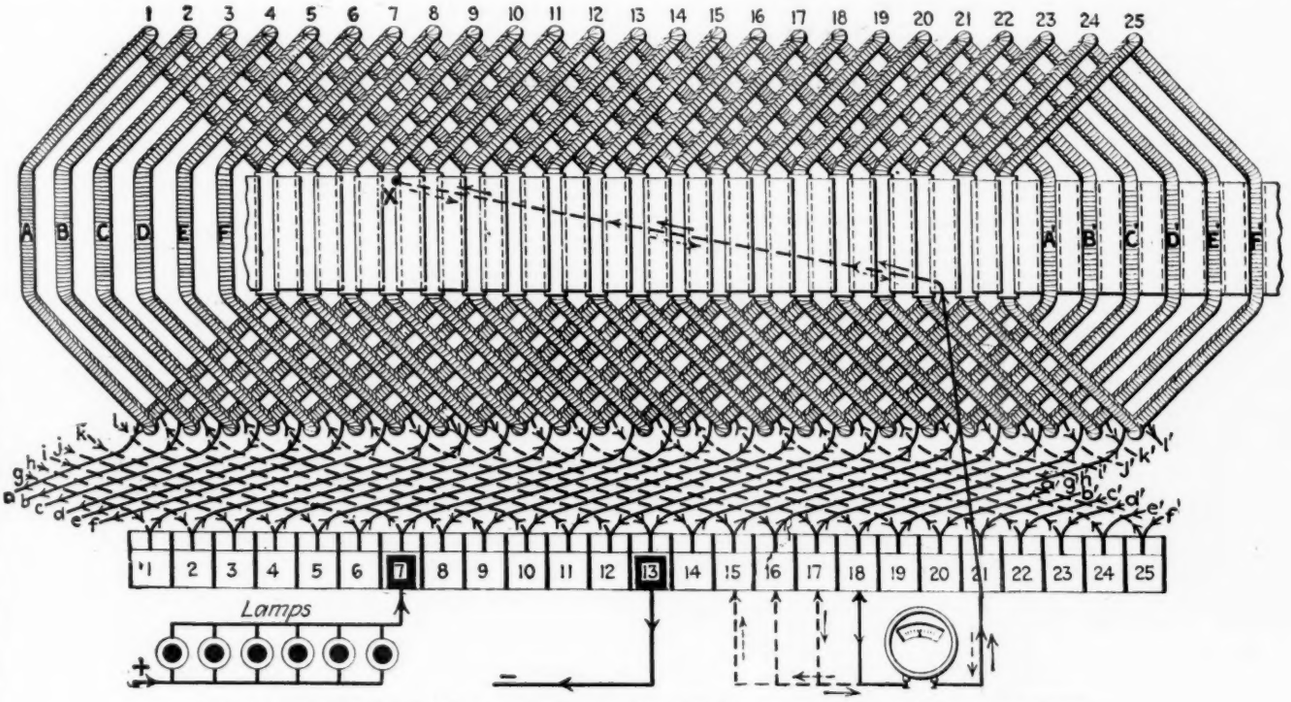


FIG. 2—SHOWS METHOD OF TESTING FOR GROUNDS WITH A MILLIVOLTMETER

In taking the readings on the commutator if, when the first reading is taken, the meter lead is connected to a segment that is a number of coils away from the defect, a high reading should be obtained, then as the meter lead is moved toward the segment to which the defective coil connects, the reading will become less and reach a minimum on the segment that the faulty coil connects to. Going beyond this segment gives a reverse reading, which will indicate that the defective coil has been passed.

The readings that would be obtained around segment

15 are similar to those that would be obtained in a parallel winding for a grounded coil. In a parallel winding the two leads of the coil connect to adjacent segments, but in a series winding the coil leads connect to segments approximately one pair of poles apart. Therefore in a series winding a grounded coil will show up on the commutator at points corresponding to each pair of poles. In Fig. 2 coil 10 connects to segments 4 and 15, and similar test results will be obtained around segment 4 as was found around segment 15. Unless the ground was in the coil exactly midway between the two segments, the readings obtained on segments 4 and 15 would not be alike. The segment to which the fault is nearest will give the lowest reading. If the ground happened to be on segment 15, then a zero reading would be obtained from this bar, while from segment 4 a reading equal to the voltage drop through coil 10 would be obtained.

After the segments that give the low readings have been found, it is an easy matter to find the coil. Disconnect the leads from the two segments that give the low reading (in Fig. 2, segments 4 and 16) and test the coil that has been disconnected with a lamp to make sure that the faulty coil has been located. After this has been done, the coil may be removed from the winding and reinsulated or replaced by a new coil, or it may be left in the slots and cut out by the winding. For example, assume coil 10 was found to be the defective one; its leads could be disconnected from segments 4 and 16 and a jumper used to connect these two segments together. The leads should be cut off or insulated and bound down with the rest of the leads and jumper. To prevent the coil from heating (for probably there will be more than one grounded turn in it), cut the coil in two at the back of the winding. This will destroy the coil, but will make it possible to put the armature into service without disturbing the rest of the coils.

New Conduit for Power Houses

A valuable addition to the list of power-house materials is a commercial line of rigid aluminum conduit, recently announced by the manufacturers. The conditions of power-house operation with attendant moisture and sulphur-bearing gases are well met by the use of a material that is particularly non-corrosive under those conditions. Various expedients have been used to prolong the life of the electrical wiring in the power house and railroad roundhouses without particular success. Continuity of light service in such applications is vital, as an interruption due to deteriorated and exposed wiring may bring disaster with it. Conditions around ash-conveying equipment are particularly severe on electric wiring, and it has been practically impossible to secure more than a few years' life using ordinary materials.

Aluminum, while resistant to corrosion itself, is further protected by the formation of a thin film of aluminum oxide on the surface of the metal, the oxide being an especially inert substance. This conduit is made from an aluminum alloy containing about 1½ per cent of manganese, giving a hard strong material that may be formed and installed by the ordinary methods applying to other conduit. The specifications, as given by the Board of Underwriters, are followed in the manufacture of this aluminum conduit, by the Aluminum Company of America, Pittsburgh, Pa.

Angularity of Connecting Rods

BY A. R. NOTTINGHAM

It is usual to express the movement of the piston of a steam engine in terms of the per cent of its stroke. There are a few machines using the Scotch yoke, as shown in Fig. 1*A*, but the standard arrangement is a connecting rod similar to that as illustrated by Fig. 1*B*.

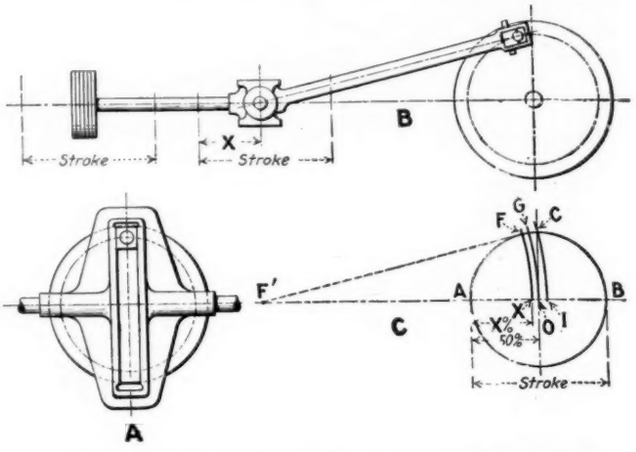


FIG. 1—RELATION OF PISTON TO CRANK POSITIONS

In the case of the Scotch yoke the piston position can be found by drawing a perpendicular through the center line of the crankpin. In the actual engine using a connecting rod, when the piston is in the middle of its stroke the crank will not be at 90 deg from the engine center line. This difference, which amounts to 5 per cent, is the error due to the angularity of the connecting rod. If there were no angularity, we would have the case of an infinite rod and could get the piston position by drawing the perpendicular through the crankpin, as in the case of the Scotch yoke.

We may get the actual position of the piston for any mechanism by drawing the kinematic diagram of the engine. This may be simplified as shown by Fig. 1*C* where, the crankpin being located at *F*, we take the radius *FF'* on the extended center line. As we swing this arc down to the center line at the point *X* the distance *AX* divided by *AB* equals the percentage of the stroke. When the crank is at *G*, the piston is in midstroke. When it is vertical at *C*, it is beyond midstroke by the amount of *OI*. The distance *OI* can be expressed in inches or in the percentage of travel. When expressed in percentage of the stroke, it becomes a correction which may be added to the ideal percentage, or that obtained by drawing the perpendicular as for an infinite rod. In Fig. 2 the corrections, for all usual rod lengths, due to angularity of the rod have been plotted. The connecting rod is usually some even multiple of the length of the throw, or the radius of the crank, and a series of curves with the ratio of this connecting rod to the crank of from 3 to 6 have been plotted.

If in the present case the crank was vertical or at 90 deg., which means the piston is at 50 per cent of its stroke for the ideal case, and if the connecting rod was five times the length of the crank, there would be a correction of 5 per cent as read to the left from the top of the curve marked 5 in Fig. 2. This should be added to the ideal percentage for the head-end stroke

and subtracted for the crank-end stroke. The true position of the piston is then at 55 per cent of the head-end stroke. If the crank were directly downward, the ideal position of the piston would be 50 per cent, but the correction would be a negative 5 per cent. In this case 50 — 5 = 45 per cent, the actual piston position.

If the angle of the crank is taken at 90 deg., as read on the right-hand scale, we read the reverse curve marked "piston position" and downward to 50 per cent of the stroke for either end. Noting this value and reading back up to the proper curve, the correction is found at the left and is added or subtracted as indicated.

Assume that it is desirable to find the percentage of the stroke for an 18x20-in. engine when a perpendicular

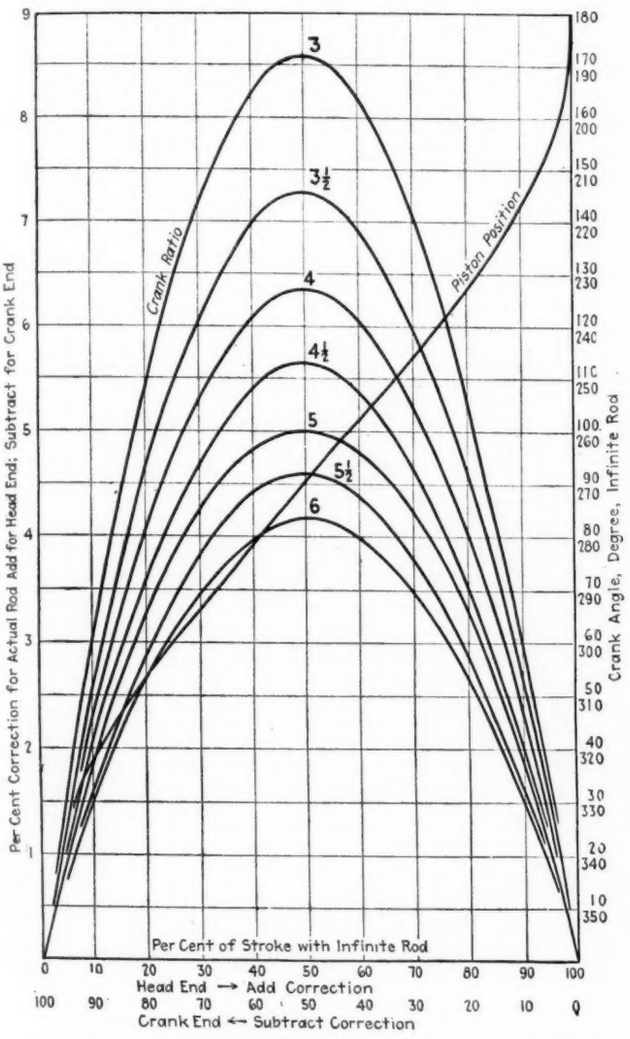


FIG. 2—CORRECTION FACTOR FOR ANGULARITY OF ROD

through the center of the crankpin falls 8 in. from the head-end dead center. The ideal percentage is $\frac{8}{20}$ or 40 per cent. This would be the actual percentage for a Scotch yoke or an infinite rod. If the engine had a connecting rod 50 in. long, it would be five times the throw. On Fig. 2 read on the head-end scale at the bottom 40 per cent. Read up to the curve marked 5 and then moving longitudinally to the left we find the correction to be between 4.75 and 5, say 4.8. As directed at the bottom, add this to the 40 per cent ideal, giving 44.80 per cent actual.

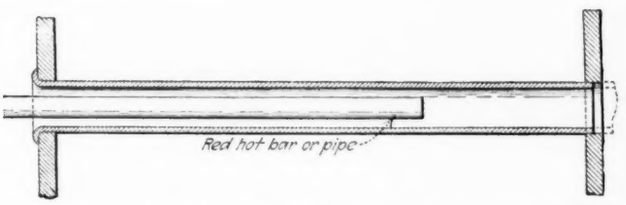
Take the same for crank-end dead center. Using the lower scale and subtracting the correction, 40 — 4.8 = 35.2 per cent actual, or 7.04 in. from crank-end dead center.

For this engine suppose it is desirable to find the percentage and piston position when the crank is 120 deg. from head-end dead center. Read up the scale at the right to 120, over to the piston position curve and down to 75 per cent ideal. For this ideal read on the 5 to 1 curve a correction of 3.8 per cent, making 78.8 per cent, or a movement of 15.76 in. from dead-end center.

Stretching Boiler Tubes

BY W. STEVENSON

Stretching of boiler tubes on repair work or new work under construction injures the tubes by the stretching of the metal and may endanger the lives of the boiler operators or of any persons who may be in the vicinity of the boilers in the event of the tubes' rupturing. The stretching of the tubes is performed in the following manner:



A HEATED BAR OR PIPE IS INSERTED IN THE TUBE

A sufficient length is allowed at one end. The tube is then expanded in place, the expander removed and the tube flared and heated. A long pipe or bar is heated in a furnace and then placed into the tube. The tube expands to the point of the least resistance, and when sufficient length is secured, the heated bar is withdrawn from the tube and the opposite end is flared and expanded before the metal has any possible chance of shrinking to its original position.

Naturally, under these conditions the tube sags and a strain is brought upon the tube close to the head. Moreover, the sagging makes it difficult to clean out the tube properly.

These conditions can be avoided only in the boiler shop by laying out the boiler plate so as to allow sufficient length for a standard size tube. Furthermore, it is important that a strong back be applied to each head and the tube sheet properly leveled before any tubes are expanded. If the tube-sheet flange should be slightly out of proportion, the next longest tube should be cut to suit the required length.

If a boiler already in service has developed a bulge in the tube sheet or headers and if the standard size tube which the boiler was designed for does not come within the required length, a new tube of extra length should be ordered immediately.

During 1921 Cuba was our third best foreign customer in the industrial machinery field, with purchases amounting to $21,307,814. Prosperity in Cuba results in large orders from the Sugar Centrals for new and replacement machinery and equipment, not alone that used directly in the processes, but also equipment to provide the necessary power for sugar production.

Nine Years with Underfeed Stokers and Illinois Coal

By C. C. COBB, Jr.

MUCH interest was aroused in the fall of 1913 by a report presented before the Chicago Section of the American Society of Mechanical Engineers by Bryant Bannister on a series of tests of a new boiler plant installed at what was then the Kewanee Works of the National Tube Co., now the Walworth Manufacturing Co. The feature of the installation was the use for the first time of the Taylor stoker with Illinois coal. Considerable skepticism was expressed at the time over the success of the venture. It is the purpose of this article to report the results that have been obtained in the nine years of operation.

The original boiler installation, which is the same today except for minor changes that will be explained later, consisted of four four-pass three-drum Edge Moor water-tube boilers, each having 273 4-in. by 20-ft. tubes arranged 14 high by 20 wide and built to operate at 200 lb. steam pressure. The steam-making surface per boiler is 6,132 sq.ft. Seven-retort 17-tuyere stokers of the hand-dump type having 108 sq.ft. of projected grate area serve the boilers.

Inside the furnace the dimensions are 8 ft. 6 in. deep, 12 ft. 9 in. wide, and 7 ft. 2 in. high, giving a furnace volume of 770 ft. When burning 9,500-B.t.u. coal at a rate of 4,500 lb. per hour to carry a normal load of 150 per cent of rating, the combustion rate per hour reduces approximately to 42 lb. per square foot of grate, or 5.8 lb. per cubic foot of furnace volume. At the peak load of 200 per cent of rating the coal consumption is 6,000 lb. per hour and the unit combustion rates are respectively 55.5 and 7.8 lb. per hour.

Each boiler was equipped with a single-loop superheater having 1,200 sq.ft. of surface, installed, as shown in the accompanying illustration, above the tube bank between the first and second passes of the boiler. This was designed to give 100 deg. of superheat at the rated load on the boiler. The boilers were originally equipped with a multi-jet soot blower for each pass, the three front ones being embedded in the baffles, which were made of asbestos hot-blast cement built on a lattice framework of small steel angles. The rear soot blower was located just in front of the rear tube header.

Each of the four boilers is served by an individual stack and also by an individual blast fan, the latter being a steel-plate volume blower, having a normal capacity of 22,000 cu.ft. per min. against 5½-in. water pressure at 386 r.p.m. The blower is driven by a direct-connected simple, vertical steam engine which also drives the stoker by chains through a countershaft, no provision being made for speed variation of the stoker with relation to the fan speed. Hydraulically operated regulators control the speed of the fan engines in accordance with the steam pressure, and damper regulators are set to maintain a slight draft over the fire—not more than 0.05 in.

In condensed form Table I gives the results of a representative portion of the original tests conducted in 1913 soon after the steam plant was put in operation. Table II gives the average results as obtained in operation for the years from 1914 up to August of 1922. These are strictly operating results, including all losses due to banked fires, firing up, very light night and Sunday loads, etc. The water blown down and for filling boilers has been subtracted.

On the average this deduction has amounted to about 10 per cent of the total water fed to the boilers; owing to the frequency of blowing down to prevent excessive foaming, the apparent boiler efficiency has been cut down considerably. That is, if the efficiencies had been based on the total water fed to the boilers, as is frequently the case in summing up plant performance, the percentage figures would have ranged from 6.5 to 7 points higher, or from 74 to 77 per cent instead of in the vicinity of 70 per cent and below. In Table II the deductions have been made and the actual evaporation given.

THE author gives data on average operating results and maintenance, relates difficulties encountered, tells how they were overcome and shows how high ratings were carried in spite of limited furnace volume.

It will be noticed that the operating steam pressure has been raised by steps during the nine years, approximately from 115 to 165 lb. per sq.in., which was done as the electric power-plant equipment was adapted to the increase. This of course, affects the flue-gas temperature and, other things being equal, would result in a decrease of approximately 0.5 per cent in the efficiency.

Table III gives typical partial analysis of the two general classes of coal as received at present for use in the boilers. The coal used in tests as reported and also the main supply for regular operation is 1¼-in. screenings obtained from Fulton County, Ill., or the vicinity, and has a high ash content of low fusing temperature. That being received now, as will be noticed from the analysis, does not equal in heat value the coal obtained previous to 1920. The B.t.u. per pound of coal as reported in Table II is an average including some Franklin County coal from Southern Illinois fields.

Water used in the boilers is obtained from deep wells, drawn from the stream just below a sandstone strata, and is treated by the cold lime and soda process in an intermittent plant. Table IV gives an analysis of the treated water, approximately as fed to the feed-water heater. The quality is uniform. It will be noticed that the water has a comparatively heavy salt content which requires frequent blowing down of the boilers to prevent excessive concentration.

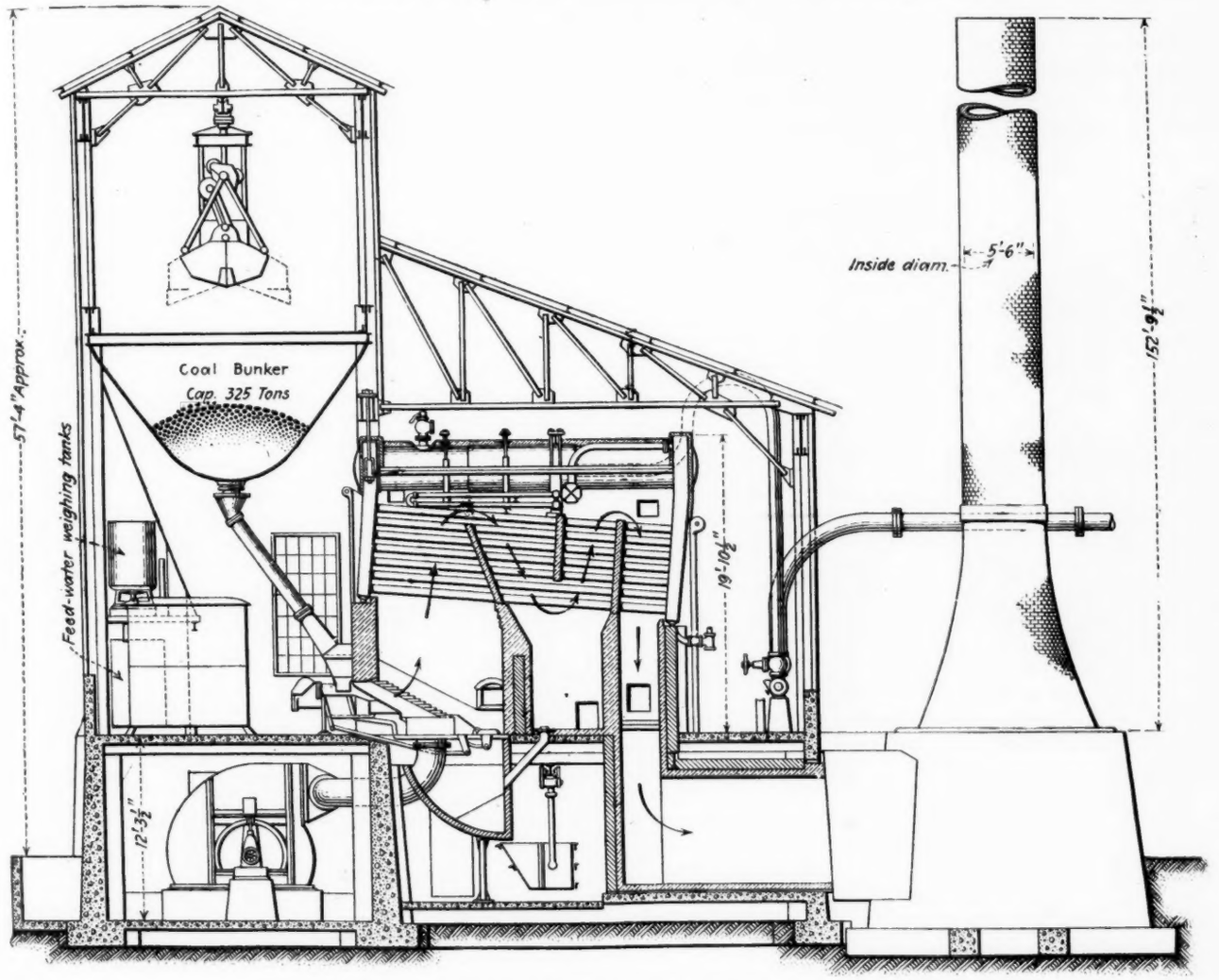
TABLE I—DATA FROM REPRESENTATIVE PORTIONS OF ORIGINAL TESTS MADE IN 1913

Test No.	2	4	7	8	10	12
Water evaporated per hour, lb.	26,700	30,418	22,792	14,617	38,359	21,721
Coal consumed per hour, lb.	3,846	4,666	3,098	1,863	6,118	3,093
Duration of test, boiler hr.	8	8	8	8	4	72
Av. steam press., lb. gage	115.1	118.5	116.0	111.9	122.9	117.6
Av. f. w. temp., deg. F.	189.6	185.3	187.1	189.4	184.0	194.9
Av. superheat, deg. F.	82.5	80.8	77.7	61.1	105.3	77.9
Av. per cent rating dev.	140.4	160.5	119.8	76.0	205.2	113.4
Av. B.t.u. per lb. coal as fired	10,002	9,811	9,563	9,706	9,977	9,302
Av. eff., per cent	79.90	79.36	80.43	81.47	78.57	80.16
Av. flue-gas temp., deg. F.	434	479	419	359	510	412

Excluding a short period of preliminary difficulties, the service given by the underfeed stokers burning Illinois coal has been satisfactory. The most serious difficulty at first encountered was the frequent breakage of the mechanism driving the lower ram, which was caused by the packing of fine ash under the lower ram extension, and resulted in the wedging and sticking of the ram. The trouble was solved by altering the extension casting so as to eliminate the half-round bottom and leave only a vertical web.

Of course this kind of coal imposes certain requirements in firing to prevent trouble from the large amount of low fusing ash. We have found that a normal load of 150 per cent of rating can be carried and good efficiency obtained with no operating difficulties. When exceeding this load very much, it becomes necessary to watch the combustion closely to keep the proper shape of fire and to prevent a "freeze up" on the bridge wall. With a furnace height of about 7 ft. 200 per cent of rating means nearly 8 lb. of coal per cubic foot, which is high when compared with modern central-station practice and is the cause of the high furnace temperatures attained. With a larger furnace we believe that 200 per cent of rating or more could be carried almost as easily as the present normal load of 150 per cent.

It has been the practice to use steam jets along the side walls at the grate level to prevent clinker adhesion. This gives satisfactory results, but at considerable expense for steam. We have been experimenting lately without the jets, but not with unqualified success. It is hoped, however, that the use of high-temperature cement in furnace walls will help solve our difficulty.



SEVEN-RETORT UNDERFEED STOKERS BURNING ILLINOIS COAL

TABLE II—AVERAGE OPERATING RESULTS SINCE 1914

Year	1914	1915	1916	1917	1918	1919	1920	1921	1922†
Water evap. per month, 1,000 lb.	20,000	19,740	26,920	29,960	27,060	31,180	34,450	20,470	26,300
Coal consumed per month, 1,000 lb.	3,100	3,075	4,132	4,657	4,420	4,548	*5,652	3,240	3,898
Boiler hours per month		1,556	1,330	1,457	1,463	1,698	1,770	1,233	1,419
Average steam pressure, lb. gage	117	118	121	150	165	166	162	162	167
Average f.w. temperature, deg. F.	202	200	197	189	191	192	195	199	197
Average superheat, deg. F.	78	81	85	84	80	74	85	75	79
Average per cent rating device		88	106	109	98	97	103	87	97
Average B.t.u. per lb. coal as fired	10,130	9,830	9,880	9,950	9,920	9,990	9,650	9,400	9,818
Average efficiency, per cent	67.9	70.0	71.1	70.5	67.5	67.5	68.4	72.7	75.0
Average flue gas temperature, deg. F.	405	407	435	449	456	454	475	437	434
Average NaCl concentration in boilers, gr. per gal.	328	329	354	339	337	352	300	258	255

* Includes coal equivalent of a small percentage of oil burned.
† January to August.

Dumping grate castings have to be replaced completely about every three years; tuyeres last about eight years and extension rams and extension grates about two years. This year we have arrived at the point where it has been necessary to begin replacing the main rambox castings due to wearing clear through the bottom of the upper cylinder. These were the old type of casting without any renewable wearing plate, and the rather rapid wear is attributed largely to the high-sulphur coal used.

We have found that a direct drive between the fan engine and the stoker, with no speed change possible, does not give the proper flexibility to maintain best conditions at all times and expect to change this arrangement at some time.

TABLE III—TYPICAL COAL ANALYSIS

	Fulton County		Franklin County	
	As Recd.	Moisture Free	As Recd.	Moisture Free
Moisture, per cent	12.8	.....	12.8	.....
Ash, per cent	17.2	19.7	10.1	11.6
Sulphur, per cent	2.9	3.3	1.3	1.5
B.t.u. per lb.	9,190	10,560	10,670	12,210

Boiler operation, as affected by the problem of scale, has been all that could be expected, largely due to the uniform water treatment. Boilers are scaled once a year of about 5,000 hours of operation, the scale being from $\frac{1}{32}$ to $\frac{3}{64}$ in. thick and comparatively soft. The problem of foaming is of importance and requires constant attention to prevent carrying water into the superheater and even beyond. This requires the blowing down of about one-twelfth to one-eighth of the total water fed to the boilers and the draining and refilling of each boiler once a month. The salt content of the water blown down from each boiler is tested every day, as a check on the proportion of blowdown. This is carried now at about 250 grains to the gallon in winter and 300 in summer, the difference being due to the more incomplete reaction in the cold-water treatment process in cold weather, resulting in a greater concentration of suspended matter in the boiler.

An average of a little more than 3 per cent per year of the boiler tubes have been replaced, nearly all of them due to cracking of the portion of the tube extending through the front header. This is caused by corrosion on the outside of the tube which calls for rerolling at times, and finally results in cracking. We believe it is due to the combined action of a highly salt water which leads slightly through the rolled joints with the expansion and contraction strains of daily on-and-off service, and a high-sulphur coal, the ash of which is carried into the tubes to some extent. There have been no tube failures during service.

The superheaters originally installed gave out by internal corrosion caused by salty water being carried into them from foaming boilers. They were replaced in 1920 by a series of loops of plain 2-in. seamless boiler tubing bent to shape in this plant and rolled into the old headers. It is evident from the data in Table II that little total superheat was lost by the change.

Changing Soot Blowers Improves Efficiency

It became evident after two or three years' service that the original baffles and soot blowers were not satisfactory. The baffles required considerable patching and the soot blowers did not clean properly, especially in the lower rows of tubes over the fire, where it was necessary to clean by hand every week end. In 1920 the front two baffles and soot blowers were torn out and replaced by Turner baffles and four new soot-blower elements. This change is largely responsible for the improvement in efficiency since that time. Our experience with soot blowers is that the furnace element lasts a little less than a year on the average, but at that they are well worth their cost.

Steel Stacks Replaced

A little history concerning the stacks, of which there are four—one per boiler—may be of interest. Originally, they were of the self-supporting steel type, unlined. After three years of service it was found that corrosion of the steel from the inside at a point in the neighborhood of 100 ft. from the base, had progressed so far as to require some remedy. This corrosion was due to condensation of the moisture in the stack gases, owing to low stack temperatures, and would not have been prevented by any partial lining. The situation was handled by cutting off the steel stack above the danger line, and then building a concrete stack, using the steel for an inner form as far as it went and leaving it permanently in place.

In 1920 Nos. 1 and 4 concrete stacks had deteriorated to such an extent as to make it necessary to replace them, entirely new stacks being built this time of radial brick, on the old foundation. This deterioration, which consisted of cracking and spalling of the concrete, was jointly due in an indeterminate proportion to the following causes: Poor concrete construction in rather cold autumn weather, and firing too soon after completion and expansion of the inner steel shell, of which the latter probably is the most important. There has been some thought of attributing this failure to the burning of fuel oil in the boilers, which, owing to the small combustion chamber, resulted in overheating the stack by delayed combustion; but as no fuel oil was burned in No. 4 boiler, it would seem that this can hardly have been a serious factor. The two remaining concrete stacks are not yet as bad as Nos. 1 and 4 were, but material is on hand for radial-brick stacks to replace them when necessary.

TABLE IV—ANALYSIS OF TREATED WATER

	Gr. per Gal.		Gr. per Gal.
Volatile and organic	0.55	Na Cl	34.61
Suspended matter	0.05	$NaNO_3$	0.08
Silica	0.75	Na O H	1.10
$CaCO_3$	1.50		
$Mg(OH)_2$	0.36	Total solids	63.14
Na_2CO_3	1.59	Incrusting solids	2.61
Na_2SO_4	23.15	Non-incrusting solids	60.53

Refrigeration Suggestions

Don't be in too much of a hurry to open the suction valve when starting the ammonia compressor, especially if the machine has been shut down for a long time without having pumped out the expansion coils and suction line. Keep your hand on the discharge valve if possible. If it gets cold suddenly and the discharge valves of the compressor work noisily, liquid is likely coming back with the gas and the suction valve should be closed off until the machine begins to warm up. If there is a slamming in the cylinder, close the suction valve until the noise stops.

Don't forget to close the suction valve when shutting down even for a little while.

Don't fail to watch the compressor piston-rod stuffing box when starting. Tighten the gland if necessary, but loosen it after the machine warms up.

Don't run with burned or hard packing. Piston rods cost more than packing.

A Well-Designed Hydraulic Testing Laboratory

By JOHN S. CARPENTER
Hydraulic Engineer, S. Morgan Smith Company

HYDRAULICS, as a science, is just as exact as pure mathematics. In its application, however, to practical conditions as are necessary to make it useful for man's needs, experimenters early found that actual performance did not agree with physical laws known to be exact. Therefore, coefficients were established by testing to take care of the departures from theoretical expectations. In the development of hydraulic machinery to its present state of comparative perfection, the hydraulic laboratory has played a prominent and very useful part.

Hydraulic Laboratory Has Contributed Much to the Development of the Turbine

Especially is this true in the field of the hydraulic turbine. The early work by Emerson at Lowell and later at Holyoke, Mass., was the forerunner of the larger public testing flume at Holyoke built by the Holyoke Water Power Co. This last flume is where the experimental work was done which has so greatly advanced the art of building water turbines. Thousands of tests have been made there, and the certified report of the Holyoke Water Power Co. is almost universally accepted at face value.

At times, however, owing to the many builders of water turbines, it was difficult to get work done in time to meet shipping dates, etc., as each wheel had to wait its turn for test in the order of its arrival at the flume.

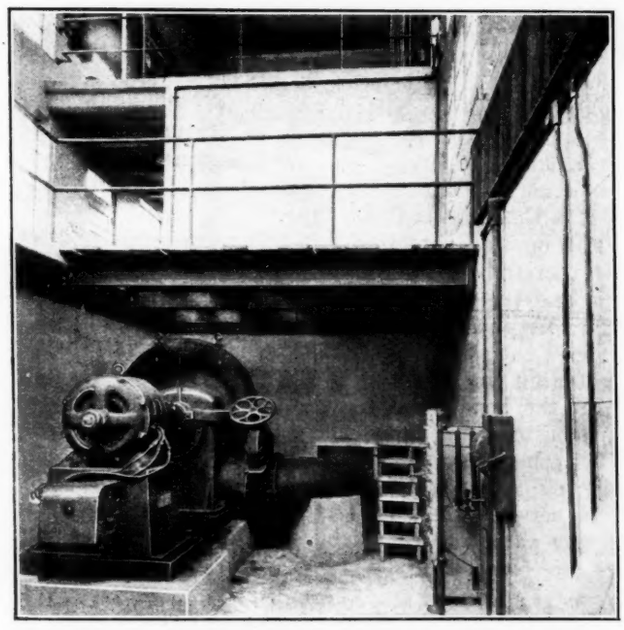


FIG. 1—PUMP FOR SUPPLYING WATER TO THE TESTING FLUME

Frequently, it would be difficult to get a test run for weeks when some builder would have a series of special tests to run. Again, the development of the hydraulic turbine has been so rapid in the last ten years or so, that a great many tests were needed by conservative builders to assure them that they were on a sound basis in the manufacture of the new high-speed wheels. Therefore, the S. Morgan Smith Co., of York, Pa., at a cost of $40,000 built a modern private test flume that could be used for testing out all their wheel designs, old, new, present and future. Also here they can test out every conceivable kind of draft tube and turbine setting and know just what it is worth in terms of efficiency and power output. Here many model sizes of their turbines have been tested out and then stepped up to Holyoke size and tested at the Holyoke testing flume. In this way the comparative performance of models and full-sized turbines is known, and these data give valuable and accurate means for predicting the performance of similar sizes and types of larger units.

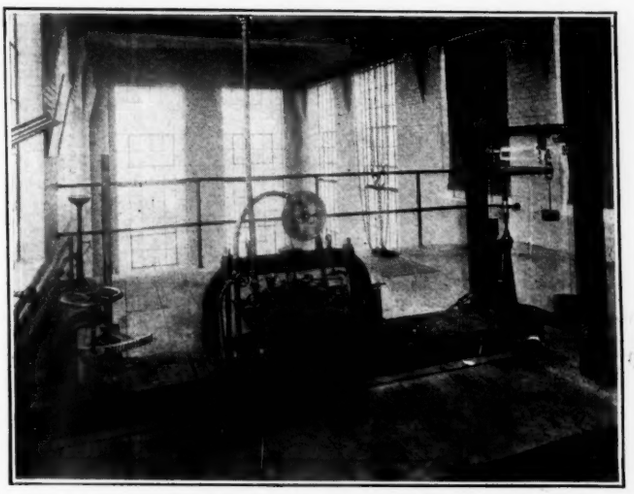


FIG. 2—HYDRAULIC BRAKE, SCALES AND GATE-OPERATING MECHANISM

The building is a two-story structure, 24 x 72 ft. in plan.

Equipment in the Laboratory

Fig. 1 shows the pump pit and the concrete tank walls. The pump is a double-suction, 9,000 gal. per min., 50-hp. induction-motor driven set and gives 12-ft. head maxim on the turbine. The pump takes its water under a head from the weir discharge pit, pumping into a baffle chamber with an overflow to keep the head constant and thence to the headrace tank. A valve is used on the discharge to regulate the flow. From the turbine discharge the water passes through stilling racks and then over a sharp-crested weir without end contraction, the weir edge being of planed strip brass. The water passes thence into the pump suction and the cycle begins anew.

Fig. 2 shows the operating floor, with Alden oil-type hydraulic brake, Fairbanks precision scales and the

gate-operating mechanism. Constant water pressure for the Alden brake is obtained from a stand-pipe projecting over the building roof some fifteen feet. The turbine speed is taken from a revolution counter similar to that used at Holyoke. The amount of discharge is indicated by a finely graduated hook gage located in a

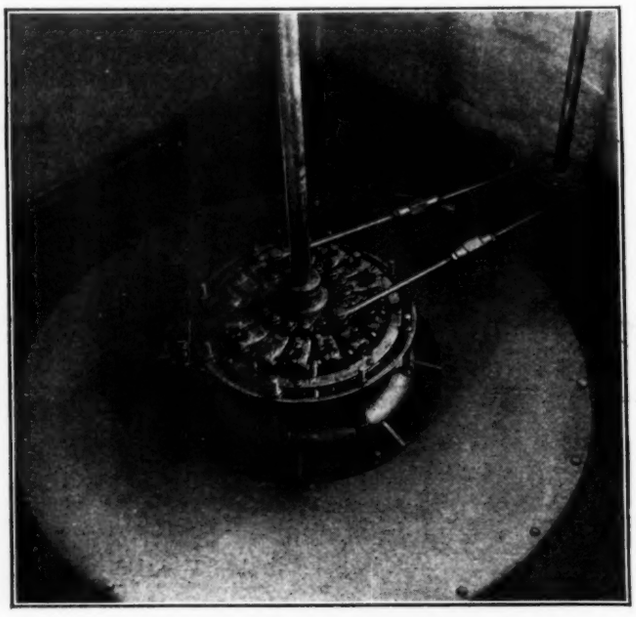


FIG. 3—TURBINE MODEL INSTALLED IN HEADRACE PIT

stilling tank in the tailrace. The actual and effective head is measured by the difference between gages in the headrace and tailrace, which head can be checked by a direct-reading head gage such as is used at Holyoke.

Fig. 3 shows the floor of the headrace pit with the test-turbine casing in place and the gate rigging connected up. The turbine is set on a large cast-iron plate

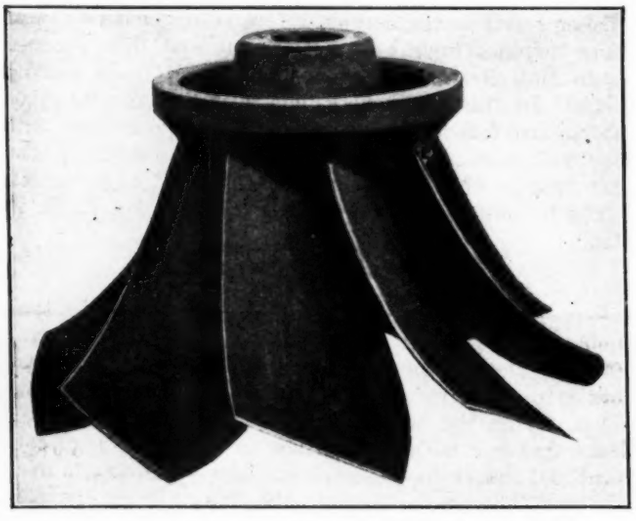


FIG. 4—DIAGONAL PROPELLER-TYPE RUNNER

which can be removed should occasion demand. By means of a side opening not shown in the pictures, horizontal turbine settings also can be tested. A 3-ton hand crane is provided for taking the turbine or other equipment out of the pit, or removing draft tubes.

A desk for the computer is furnished, and a handy work bench is provided for any final fitting or adjustment in the parts. Regularity in taking readings is provided for by a double-pendulum electric time clock, rings being heard every half-minute with a warning ring before the actual reading time.

Fig. 5 shows two flat-type propellers for test, having 4 and 5 blades; other models have only 3 blades. Fig. 4 shows a diagonal type of propeller for test. These runners and many others of the American mixed-flow type have been tested out with good results, and in this

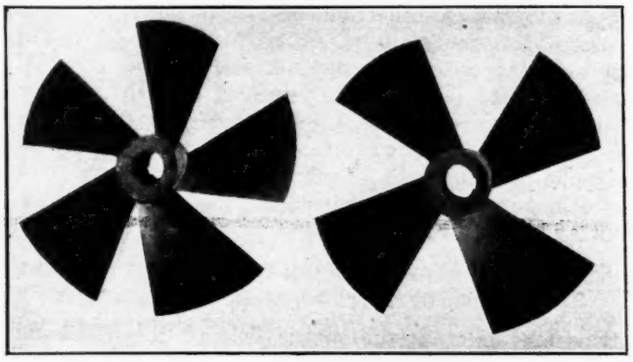


FIG. 5—MODELS OF FLAT PROPELLER-TYPE RUNNERS

way complete data for design are obtained. Credit for the design of the testing laboratory is due George A. Jessop.

Boiler Inspecting—III

By James F. Hobart

DESCRIBES in detail the different steps in the inspection of a horizontal return tubular boiler, points outs where special attention should be given, and shows method of determining plate thickness.

IN A previous article it was stated that the boiler data should be obtained as far as possible, but there are some questions which can be answered only after the boiler has been examined and measurements made of the thickness of plates, pitch of rivets, number and arrangement of braces, etc. Let us consider, first, the inspection of a horizontal tubular boiler 66 in. by 15 ft., as it is the most common type.

Pull on the inspection suit and settle arms and legs well therein before buttoning up; smooth out the wristlaps and see that they lie even and level against the flesh; fit the ankle-straps snugly and be careful to arrange the suit-legs smoothly about the ankles before tightening the straps.

Fit the hood well around the face and see that the cape buttons are all pushed fully through their holes. When a hood becomes stretched from wearing and washing, fold a handkerchief to the proper shape and slip it in between the chin and the hood. That will take up any slack and cause the hood to fit tightly around the face, so that no dirt can get in.

Entering the Firebox

When ready to crawl into the firebox, take care to have the hammer and candle at hand; matches, too, must be taken along, for the candle is liable to be extinguished a few times before you are finished inside of the boiler. It is advisable to have a small pocket with a buttoned flap, placed on the left breast of the suit. In that pocket you should always carry a clean

rag or a handkerchief, as you will be liable to get something in the eye and a cloth is vitally necessary.

Once inside a firebox each experienced inspector has a way of his own of getting results. The writer always rolls over upon his back, picks up the hammer and candle and then looks around the furnace. The candle will be held far out, this way and that, until its light has been throw from one part of the furnace to another and everything in sight closely noted.

Take the fire-sheet of the boiler first, and as the candle is moved around from side to side, should there be the slightest bulge in the sheet, shadows will be thrown by the light, and will indicate any tendency of the shell to bulge. Look at the brickwork. See if the furnace lining is in good condition and note if any portion of the setting has fallen away, or that the bricks are resting against the boiler.

Importance of Making Notes

In a well-designed boiler furnace there is room for the body to sit upright, and you should now turn around, face the door and note the condition of things in that portion. And remember each and everything you see, which is not exactly right, must be remembered and later written in your report, and the sooner you make these notes after you get out of the boiler, the more accurate your report will be. It may be well at first, to make the outside inspection and write down the necessary notes before going inside the boiler.

Should the boiler be one with a "dry sheet" extension to lap into the brickwork, there is likely to be trouble along the edge of that sheet where the bricks may have burned or fallen away and the sheet itself may have been more or less burned, even back to and into the rivets that hold the head! The illustration, Fig. 1, shows what is liable to happen when a dry sheet is burned, although the burning should have been stopped long before it reached the extremity shown in the cut. Regular inspection would have halted this trouble.

The burning of the dry-sheet is caused by failure of the brick setting of the boiler. The brickwork crumbles or burns away, letting flame draw through between the

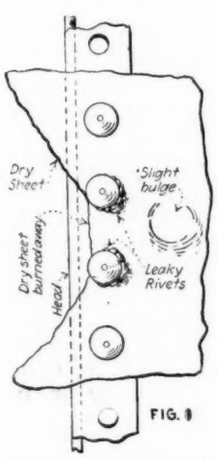


FIG. 1—BURNED DRY SHEET

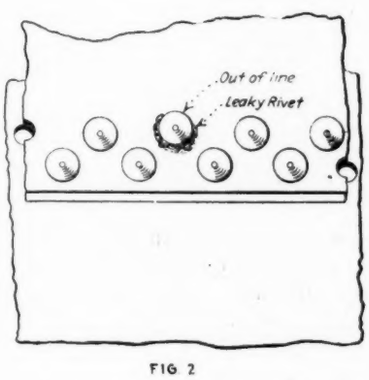


FIG. 2—RIVET OUT OF LINE IN LONGITUDINAL JOINT

brickwork and the dry-sheet. The inspector should watch this matter closely, instruct the owner or engineer and insist that his instructions be followed.

A boiler made with a flush front has no dry-sheet, therefore it is free from the trouble shown in Fig. 1, but it is likely to leak gases past the front end. The brickwork gets out of shape and flame draws through between the boiler and setting, passing directly into the uptake.

Watch closely for the stretchings or bulges of a portion of the fire sheet directly above the furnace. A bulge is usually caused by dirt or mud adhering to the inside of the boiler so firmly that no water can reach the plate, which becomes so hot that its strength decreases to a point where the internal pressure can

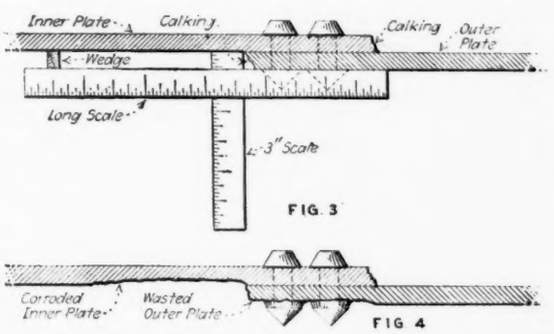


FIG. 3—TOOLS NECESSARY TO DETERMINE THICKNESS OF PLATE. FIG. 4—CORROSION OF PLATES AT THE RIVETED JOINT

stretch the steel, forming a greater or less "bag." This cannot happen if the inside of a boiler is kept clean. But bear in mind that impurities contained in the feed water are never carried off with the steam. The sediment remains in the boiler and sometimes the contents are found to be as thick as syrup from accumulation of impurities. The inspector who finds a new bulge, will surely recommend that the boiler be "blown down" frequently, or other steps taken to relieve the boiler of sediment which not only is dangerous, but causes loss of fuel and low boiler efficiency. When a large quantity of earthy matter and chemical salts are contained in the boiler, a higher degree of heat is required to liberate steam. Pure water boils at 212 deg. in an open vessel, but if the water in a boiler is highly concentrated it, may have to be heated to 220 deg. before steam will be liberated.

The inspector should be on the lookout for dirt in the boiler and should warn against that condition as a cause of bulges and perhaps other sheet failures. Other evidence of the dangers from dirty water will be found by the inspector when he gets inside of the boiler.

Having looked over everything at the front of the boiler, the inspector should move toward the bridge wall and note conditions of boiler and setting as he moves along. The condition of the grate should be closely noted. Holes in a grate cause loss of fuel, and warped and plugged grate bars do not tend to increase boiler efficiency. Observe the bridge wall closely and note its condition and report any crumbling away or too great height thereof.

In some older boilers, where narrow sheets were used, there may be found a row or two of rivets around the boiler directly above the furnace or front combustion chamber. Where this is found, the inspector should give them close attention. He should examine the rivets in this joint carefully to see if any of them have been leaking. This will be indicated by a deposit of chemical salts around the rivet heads. From this joint the inspector may obtain by measurements the data re-

quired about pitch of rivets, distance apart of the rows, etc., and as will later be described, he may also here determine the thickness of shell plates.

Crippled Rivets

There is one defect which the inspector should always be watching out for, particularly in a new boiler or one which he has never inspected before. This is the crippled rivet, or one out of line with the other heads, as shown in Fig. 2. Here, one rivet head is found to be out of line, and it also shows evidence of leakage by the deposit around the rivet. All rivets that are found in this condition should be reported, because one weak rivet places just so much extra stress upon adjacent rivets. The object of the inspection is to discover the weak places and have them made good before their weakening influence can spread to other parts and become dangerous. Therefore, do not consider anything, however insignificant, which you think is not quite right, to be too trifling to require consideration.

Measuring Plate Thickness

At some convenient plate edge take means to measure the thickness of the plate. About the best tools for doing this are those shown in Fig. 3. They consist of a 3-in. scale graduated to thirty-seconds, a straight-edge in the form of another steel scale 12 in. long and a wooden wedge. Any straight piece of steel will answer for the longer rule, which need not be graduated. A straight piece of wood and a two-foot carpenter's rule may be used, but the two steel scales are preferred. The wooden wedge should be approximately 4 in. long, ¼ in. and 1 in. thick at its ends.

Fig. 3 shows how the writer usually measures the plate thickness of a boiler. At any convenient seam, and usually at two or more, both inside and outside, the scales and wedge are used as shown. First, the metal is well cleaned by scraping it with the hammer-peen, then the long scale is placed in position as shown, and the wedge adjusted until the long scale lies parallel with the inner plate. The scale must, of course, be held in position during the adjustment and placing of the wedge, and the testing with the short scale to determine when the straight-edge and the inner plate are exactly parallel.

If the long scale is simply laid against the outer plate, it will be impossible to tell whether the scale is in proper position or not, for the edge of the outer plate may have been burred up a little when the calking was done, then the outer end of the scale would be too far from the inner plate, and measuring as shown would give an incorrect measurement.

On the other hand, should the edge of the outer plate be wasted away, particularly close to the edge, then the end of the long scale would lie too near the inner plate, and the scale measurement would give a reading actually less than the thickness of the outer plate. By using the wedge to keep the long scale parallel, any extra thickness or burring up at the edge of the outer plate may be quickly detected and this should be removed before final measurements are taken.

The Thinnest Plate Governs

But, should the plate actually have wasted away at some point, the actual instead of the original thickness of the plate must be ascertained. No matter how thick a plate may be in the middle or anywhere else, if it be thin for even a few inches along a row of rivets, then the thickness of that wasted plate should be used when determining the safe working pressure on the boiler.

Sometimes it requires almost instinct or intuition to detect a thin plate, and sometimes they are not found and the boiler continues to operate with a danger spot in it which must be taken care of by the factor of safety—and that is what the factor of safety is for.

With the peen of the hammer, feel along the edge of the sheet and pay attention to any roughness to be felt there. Check the thickness of the plate with the steel scales and wedge if necessary, to determine whether the plate has wasted or become thin at or near the joint, as shown in Fig. 4. Corrosion of the plates may take place anywhere on the surface, but it is more frequently found where the plates lap. However, the inspector should bear in mind that a dangerous thin spot may be found anywhere in the boiler surface, he should take every precaution to find such places when they are present.

Use the Hammer

When you look over the outside of a boiler shell, don't forget the hammer. The experienced inspector looks at a portion of the boiler and then strikes that part with his hammer or at least scrapes the part with the peen. Soon you will find that the tap of the hammer tells you a whole lot about the condition of the plate, and scraping the plate with the hammer peen will often give a clue as to where corrosion has taken place.

Be sure to tap with the hammer those rivets that show signs of leakage or corrosion around them, also scrape the hammer-peen along the edge of the plate, at the joint. If the plate feels rough do not fail to examine it carefully and check for thickness.

The cross-peen of the hammer should be kept sharpened, to make an effective scraper, for considerable scraping may have to be done by the inspector, especially when the boiler shell has not been well brushed or otherwise cleaned for inspection.

Water Power in Sweden

The water power of Sweden is estimated at four to six million horsepower. That which is considered worth utilizing, and which it is supposed will be required during the next fifty years, has been estimated at about three million horsepower.

Approximately 1,250,000 horsepower is at present utilized, by far the highest percentage thereof being the available power in the south of Sweden. With an annual increase of 40,000 to 50,000 horsepower in the water-power machinery installed, the water power in the south of Sweden up to Dalecarlia will be utilized in fifteen to twenty years. There still remain millions of horsepower unused in Norrland. This is sufficient to supply, in a reasonably near future, the general and industrial requirements of Norrland, and besides leave a considerable surplus for central Sweden, where the greater part of the industry of the country will remain for a long time to come. The State owns in middle Sweden the hydro-electric stations at Trollhatten, Alvkarleby and Motala and a steam reserve plant at Vasteras, as well as important waterfalls in the north of Sweden. In order to equalize power supply and demand, a trunk-line system has been planned, comprising the whole country. The line from Trollhattan to Vasteras is completed.—From "Swedish Year-Book."

EDITORIALS

F. R. LOW, EDITOR

Nine Years with the Underfeed

ELSEWHERE in this issue are given the results of nine years' operation in an underfeed stoker plant. As stated, the stokers were the first of their particular type to burn Illinois coal, and at the time of installation there was considerable skepticism as to the ultimate success of the venture. Some preliminary difficulties were encountered, but as soon as the economical limits of the installation and the operating routine were established operation went along smoothly and with uniformly favorable results.

Compared with the test figures that usually appear in print, the efficiencies given in the tabulated data may seem low, but it must be remembered that these figures are yearly averages including all losses imposed by banking, firing up, light loads, inferior coal, and the use of feed water of such heavy salt content as to necessitate a blowdown approximating 10 per cent of the total feed, to prevent priming. Incidentally, deduction of this blowdown water as well as that for filling boilers has made a difference larger than usual between apparent and the actual efficiencies obtained. On the basis of total water fed to the boilers, the efficiencies in the present case would have ranged from six to seven points higher than those appearing in the article. These deductions, of course, are proper but, due perhaps to their exact values not being known, they are not often made when recording the performance of a plant of moderate size.

By a furnace volume, small when compared with late practice, capacities have been limited normally to 150 per cent of rating and for short peaks to 200 per cent. From the dimensions given, there is 7 cu.ft. of furnace volume per square foot of projected grate area, or at 150 per cent of rating, 0.17 cu.ft. of furnace volume per pound of coal burned per hour. These figures may be compared to the modern range of 0.3 to 0.5 cu.ft. or to 20 cu.ft. of furnace volume per square foot of grate.

Notwithstanding the restrictions mentioned, it has been possible so to improve the installation, principally by new baffling and more efficient soot blowers, that an average operating efficiency of 75 per cent day in and day out for seven months in 1922 was maintained. For a pioneer installation in the Middle West, handicapped by the numerous factors mentioned, this is indeed exceptional economy.

The Superheater Problem

SUPERHEATERS are generally placed at the top of the first pass in water-tube boilers. In this position they receive the furnace gases at a certain temperature depending on the load on the boiler, on the percentage of excess air and on furnace conditions. The superheater at a given load on the boiler will furnish its specified superheat, but this degree of superheat will vary as the load on the boiler increases or decreases. In power-plant practice it is usual to run large boilers at about one hundred and sixty per cent of rating, except on peaks, and to specify that a certain degree of superheat must be furnished at this load. At lower loads the superheat will drop below this specified figure, while at higher loads it may increase above this amount.

Now it is well known that the boiler alone should operate at its highest economy at one hundred to one hundred and twenty per cent of rating, and it would be convenient where boilers must be banked to allow the boiler to stay on the line until the load has become as low as 90 per cent rating at least with no appreciable decrease in boiler economy alone when auxiliaries are not considered.

Such a decrease in load, however, would cause a considerable decrease in superheat in nearly all boiler plants. The serious effect of this decrease is realized when one remembers that the steam consumption of the main turbine increases with a decrease of superheat. It may be assumed that fifteen degrees Fahrenheit drop in superheat will lessen the station economy about one per cent. Hence should thirty degrees drop in superheat occur at ninety per cent rating it will cause an increase of two per cent in station fuel consumption in spite of the fact that the boiler efficiency may be substantially constant. This consideration is frequently overlooked by engineeers.

A superheater is now needed that will maintain constant superheat at all boiler ratings. The plant efficiency will then not be dependent on superheater performance. The location of the superheater down nearer the furnace and among the tubes of the first pass may tend to correct the trouble, and this is now being tried out in several plants. Radiant heat superheaters on the furnace walls are said to give this desired constant superheat. The designing engineer, however, insists on test results from a number of stations to prove whether or not this can be done. Since superheat so greatly affects turbine and station economy, superheaters deserve more careful study than has formerly been given to them.

The Balanced Plant

ONE of the valuable lessons driven home by the general study of heat balance during the last few years is that no piece of apparatus in a power plant can be properly evaluated without a clear understanding of its position in the general scheme.

A power plant may have good boilers fired by good stokers; the steam generated may be transmitted through good piping and fittings to high-grade turbines which exhaust to the best of condensers; yet the plant may be a failure from the engineering and economic point of view. There must be a proper balance in the sizes and characteristics of the various units. Insufficient capacity at one point in the chain may tie up the whole plant. Over-capacity at another may mean wasted capital. The steam lines must be neither too large nor too small. The heat insulation must be scientifically proportioned. At each point it must be determined just how much money may properly be spent for increased

economy and how much for reliability. Everywhere it is an intricate problem in balancing, which requires not only technical knowledge but long experience and rare judgment. It is this necessity for balance that makes power-plant design one of the most difficult of all the practical arts.

Of course the operating engineer is not ordinarily called upon to design a complete new plant. But he must often plan additions and changes. At such times he needs the same sort of skill that marks the successful planner of cities, the man who can size up present conditions and clearly picture the enlarged metropolis of twenty years hence, with its shifted centers of activity and its new streams of traffic.

How fast will the power load grow? Will the process-steam and heating load increase in proportion? What apparatus suitable for present needs is likely to be rendered obsolete by future developments? Would it be well to provide for the use of other fuels? Must land for expansion be bought now if future growth is not to be blocked completely? Should the stack, about to be erected, be designed for the present boiler capacity or twice that amount? These are some of the questions the engineer must meet with open mind, and to whose proper answer he must apply all his skill and judgment.

To be properly fitted for such decisions, he must, of course, have a good understanding of his present equipment. But much more is necessary. He must have gained, by everlasting study, a general knowledge of other types of equipment and of other possible combinations. Through reading and contact with his fellow engineers he must have absorbed more experience than he could pick up by himself in a lifetime.

An engineer so prepared will always keep his plant in balance so far as is humanly possible and will not be caught napping when the day for the big expansion arrives.

The Engineer and the Engineering Society

ENGINEERING is becoming more and more the dominating factor not alone in the economic, but also in the social and political relations of nations. The problems of transportation, generation and distribution of power, irrigation, road building, elimination of waste and others are all of vital importance to a people living in a modern civilization. In each of these, the greatest single factor is engineering; in fact, everything that is of material benefit to the human race has been made possible by engineering. However, this does not excuse the engineer in whatever capacity he may be in, from responsibility, but rather adds to his charge. If our present civilization is to endure and our standards of living are to be maintained, then the scientists and engineers of the future must accomplish even greater achievements than has been done in the past. What this development means can best be expressed by saying that present scientific and engineering accomplishments have made some of the wildest conjectures of forty years ago commonplace devices of today.

If there were no other reason than the foregoing, then every engineer should belong to at least one society that represents his chosen profession. Brilliant as may be the accomplishment of the few great pioneers, it must rest with the collective effort of the many to carry the discoveries of these great thinkers to their full fruition. No individual can assist in the work without being benefited. No engineer, if he is going to progress, can afford to stay outside the organizations composed of men whose common problems are his. It is here that engineering knowledge gained by experience is made common property. Fortunately, the leaders in engineering thought realized this early in the inception of the different branches of engineering, and founded what have become the great national engineering and scientific societies of today.

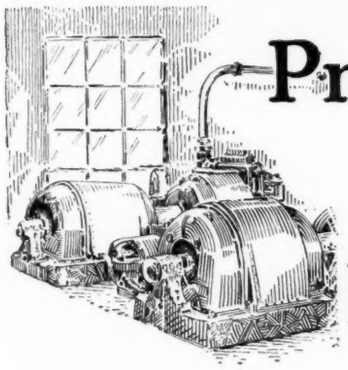
As to what has been accomplished by engineering organizations, one has to consider such work as that being done by the American Engineering Standards Committee, which is actively working at the present time on more than sixty projects. The Standardization Rules of the A.I.E.E., the Power Test Code and Boiler Code of the A.S.M.E., the work of the Power Club are all exhibitions of what is being done for the benefit of engineers in general by the organizations mentioned and many other engineering bodies. If it had not been for the collective effort by the members of these organizations, all branches of engineeering would be lagging far behind the enviable position they occupy today.

One thing that every member of an engineering society must keep in mind is that the organization is not a closed corporation to which he comes to purchase something. Many enter such organizations with this idea and feel that simply because they pay dues everything should come their way. Such an attitude invariably leads to disappointment. Each member is a part of the association, and just in the degree that he contributes to the activities may he expect to be benefited. If he fails to attend the meetings or, when he does, seeks the exclusiveness of his own company rather than that of others, or fails to respond when the officers request the opinion of the membership on subjects for discussion, and in general complains how others conduct affairs without taking an active part to bring about a change, an unpleasant awakening is the result. Only by whole-hearted co-operation with the membership as a whole can the individual expect to obtain the many benefits that are to be derived from such associations.

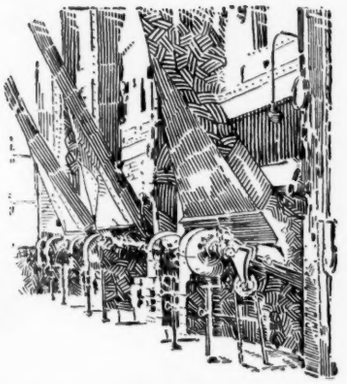
Through its vice-president, J. Parke Channing, the Federated American Engineering Societies has urged that the successor to Albert D. Fall, retiring Secretary of the Interior, be either a professional engineer or a man trained in engineering thinking. If the accomplishments of the Department of Commerce during the last two years are to be taken as a criterion, the President would be making no mistake in placing a second engineer in his Cabinet. This would be especially fitting, inasmuch as the Department of the Interior has to deal very largely with problems of an engineering character.

The Federal Coal Commission has asked Congress for four hundred thousand dollars to complete its investigations. The task is stupendous, and to risk handicapping the work at this stage through lack of funds would be fatal. It is hoped, therefore, that our national legislators will be broad enough to appreciate and meet the necessity.

Some economists believe we are in for another period of rising prices bordering on inflation. Rising prices are an indication of better business, but should always be halted before they reach the danger point of involving a buyers' strike. Let the experience of two years ago be a lesson.



Practical Ideas *from* Practical Men



Engineering Students in American Universities

Some time ago it was necessary for me to find the number of engineering students enrolled in the American universities and colleges at various times. A careful study of the "Industrial Arts Index" gave only one reference of any value (*Power*, Aug. 8, 1916). This article in *Power* was taken from statistics compiled by the United States Bureau of Education and presented to the Society for the Promotion of Engineering Education. By going over in detail all the recent bulletins of this society, I finally found figures for the enrollment during the year 1921-22. These are given in Table I and no doubt will interest many readers

TABLE I—ENROLLMENTS IN COLLEGES OF ENGINEERING ACCORDING TO SPECIALIZATION, FOR 1921-22

Curriculum or Specialization	Total
Civil Engineering	15,991
Mechanical Engineering	11,834
Electrical Engineering	12,200
Chemical Engineering	5,028
Architecture	1,026
Architectural Engineering	574
Administration Engineering	725
Textile Engineering	408
General Engineering	764
Industrial Engineering	389
Agricultural Engineering	367
Commercial Engineering	277
Ceramic Engineering	166
Naval Engineering	112
Electrochemical Engineering	95
Marine Engineering	59
Aeronautic Engineering	62
Railway Engineering	49
Sanitary Engineering	34
Chemistry	427
Physics and Science	84
Industrial Education	6
Industrial Management	9
Engineering Economics	22
B. S. Degree	14
Other Specialties	23
Mining and Metallurgy	2,669
	53,414

The figures given in Table II are interesting in comparison with Table I as they show what a phenomenal growth there has been in the number of engineering students in the last few years.

TABLE II—ENGINEERING STUDENTS IN AMERICAN INSTITUIONS

Division of Engineering	1914–15	1909–10	1904–05
General Engineering	6,059	7,096	1,893
Chemical Engineering	2,383	869	759
Civil Engineering	7,182	7,889	7,356
Electrical Engineering	6,637	5,450	5,240
Mechanical Engineering	7,751	6,377	6,654
Mining Engineering	1,922	2,656	2,547
Other Engineering	958	.....	172
Total	32,892	30,337	24,621

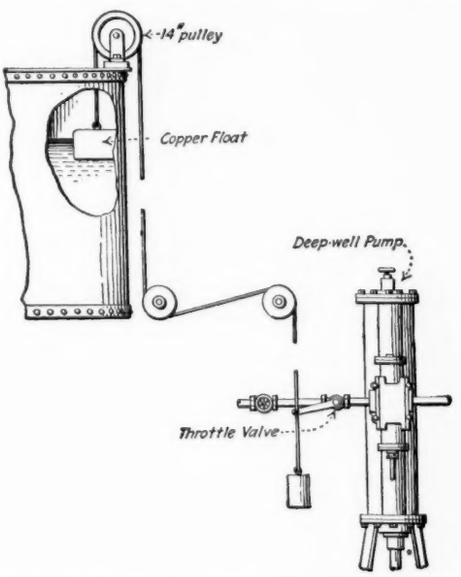
Comparison of these tables also gives some idea of the large number of specialized courses now being offered by the engineering schools, which is a comparatively recent development in engineering education.

M. A. DURLAND, Asst. Prof. Mach. Design,
Manhattan, Kan. State Agricultural College.

Speed Regulator for Steam-Driven Deepwell Pump

A steam-driven deep well pump is used for supplying water for certain manufacturing processes in a factory. The water is pumped into a tank on the roof of the building. The flow from the tank to the different departments of the works is intermittent and irregular; hence the speed of the pump must be changed frequently in order to keep the water from either running low or overflowing. For this purpose the engineer installed the automatic water-level regulator which is shown in the accompanying sketch.

A heavy copper float is suspended in the tank from one end of a small wire rope. The rope passes over a 14-in.



FLOAT IS FLEXIBLY CONNECTED TO THROTTLE BY MEANS OF WIRE ROPE

pulley mounted on top of the tank, and two intermediate pulleys, and is attached at the other end to the lever of the pump throttle valve. The throttle is of the quick-acting type as used on hoisting engines. As the water falls in the tank, the weight of the float opens the throttle; as the water rises, a counter-balanced weight attached to the lever closes the throttle.

With this regulator the water lever is kept within a range of less than 6 in. But the serviceableness of the device depends largely upon keeping the pulley bearings well oiled and the packing of the throttle stem frequently renewed.

A. J. DIXON.
St. Louis, Mo.

One Way of Supplying Temporary Service

In a plant where street lighting was furnished temporarily to 6.6-ampere series incandescent lamps from a 2,300-volt service, the nature of the contract did not justify purchasing a standard regulator. To take care of this load a reactor was made from the core of an old transformer on which we wound cotton-covered wire until a suitable value was obtained, by trial. This was immersed in a tank of oil and served the purpose nicely. An ammeter was available, and close adjustment could be obtained by means of a small water resistance. Inasmuch as the circuit contained no arc lamps, the fluctuations were neither large nor rapid and could be cared for by hand.

The ammeter was calibrated for a 30-ampere full-scale deflection with 5 amperes in its coil. We had available a 15- to 5-ampere series transformer. When using this, the ammeter showed a double reading; that is, a reading of 13.2 amperes was correct for 6.6 amperes in the line. This gave a good open indication on the center of the scale and made it easy for the operator to adjust the current to the required value.

Bowling Green, Mo. COLIN K. LEE.

Polarity of Instrument Transformers

To insure correct operation of electrical instruments and relays provided with more than one winding, such as synchroscopes, wattmeters, power-factor indicators and directional-current relays, it is necessary that a definite relation exist between the instantaneous directions of the current in each winding. Diagrams showing the correct connections applying to such apparatus are furnished by the manufacturers, and the polarities of instrument transformers of recent construction are given in instruction books or indicated by marking the transformer leads.

Polarity marks are used to indicate the relative instantaneous directions of current flowing in a given primary and secondary lead of an instrument transformer, and it is customary to mark the leads with

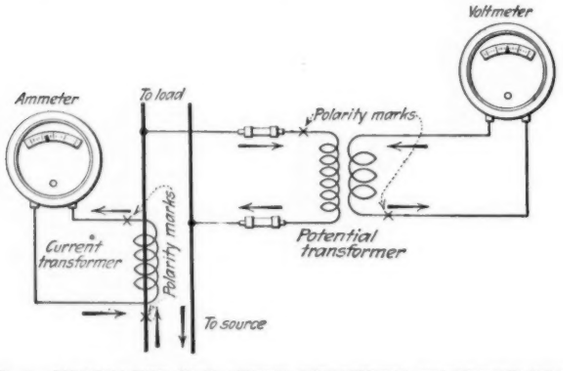
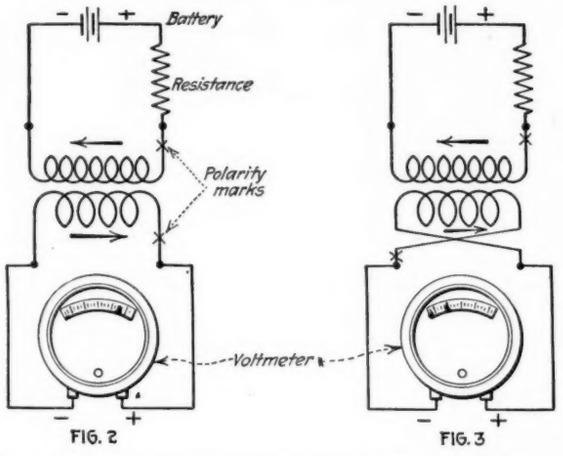


FIG. 1—INDICATES RELATION BETWEEN CURRENT FLOW IN TRANSFORMER WINDING AND TERMINAL MARKINGS.

either red or white paint. The significance of such marking is that, with current flowing into the marked primary lead, it will, at the same instant, be flowing out of the marked secondary lead, as indicated in Fig. 1. Polarity marks are indicated on connection diagrams by large dots or preferably by small crosses, as in Fig. 1. It sometimes happens that the polarity marks are obliterated, by being painted over or by wear, hence it would be an advantage if the polarity were indicated on the name-plate of every instrument transformer.

Should the polarity be unknown, it can be obtained from the manufacturer or determined by a simple test. This test is suitable for both current and potential transformers, and it is made by applying direct current at low voltage to the primary winding, with a low-reading voltmeter connected to the secondary winding, as in Figs. 2 and 3. If a positive deflection is observed when current is applied, the direction of the current in



FIGS. 2 AND 3—CONNECTIONS FOR POLARITY TESTING.

the secondary lead connected to the positive terminal of the meter is the same as that in the primary lead connected to the positive supply wire, Fig. 2, and these two transformer leads would be suitably marked. If a negative deflection is obtained, as would be the case (Fig. 3) when current is applied to the primary, the secondary lead connected to the positive voltmeter terminal is negative. In each case the deflection obtained when the primary circuit is broken will be opposite to that observed when the circuit was completed. When making the first test, it is advisable to use but one or two dry cells with resistance connected in series with the primary winding to avoid possible damage to the voltmeter. Only sufficient current should flow through the primary to give an easily observed deflection on the voltmeter. It is desirable that the zero point be about the center of the scale, so that the negative deflections can be more easily observed. Only those deflections obtained when the circuit is made through the primary are considered.

If a low-reading voltmeter is not available, a 150-volt instrument may be used by increasing the direct-current voltage applied to the primary winding. A direct-current ammeter used in connection with a shunt can be disconnected from the shunt and used as a millivoltmeter when testing for polarity, and large deflections obtained by using two or three dry cells, since a full scale deflection results when the voltage applied to such an instrument is but 0.1 to 0.2 of a volt.

While testing a current transformer having a ratio of 200 to 5 amperes, nearly a full-scale deflection was obtained on a voltmeter giving a full-scale reading at 60 millivolts, with 3 volts applied to the primary winding, and a satisfactory indication was obtained with a 5-volt instrument with the same voltage applied to the primary. An easily observed deflection was obtained on the 60-millivolt instrument when 3 volts was applied to the primary of a 2,200- to 110-volt potential transformer, but 30 volts was required to give a satisfactory indication on the 5-volt instrument.

Belden, Calif. RALPH BROWN.

Comments from Readers

Water-Tube Boilers at Sea

In a recent issue there appeared an article entitled, "Navy Predicts Water-Tube Boilers on All Passenger Ships." In this article it is stated that because of the element of safety, reduced weight and quick steaming of the water-tube type, in comparison with the Scotch type, their use will extend at sea.

I have no doubt that the use of water-tube boilers will increase at sea for various reasons, but the increase in safety is not one of them. I am aware of but one explosion of a Scotch boiler at sea, and that was on a tug or similar boat, while there have been innumerable tube explosions of marine water-tube boilers, with serious results. As for its being a legal requirement that water-tube boilers should be used on passenger ships, there is not the slightest ground for such an enactment, and nothing but sophistry and propaganda could bring it about.

When the "Imperator" (now "Berengaria") was designed, the drawings showed Scotch boilers, but the passenger department made such demands for more passenger accommodation that water-tube boilers of the Yarrow type were substituted for Scotch in order to save weight. As it is, the immersion of the ship was too great, even with every possible elimination of weight. If I remember rightly, Scotch boilers weigh about three times as much and cost about twice as much as water-tube boilers. Concerning the quicker steaming of water-tube boilers, there is absolutely nothing in this after steam has once been raised, as additional heat from harder firing can only produce steam no matter how much water a boiler contains or how much steel there is in it.

F. W. DEAN.

Boston, Mass.

Welding Tubes in Tubes Sheet of Boilers

In the Jan. 30 issue Mr. Williams and Mr. Nagle described various applications of the electric arc weld. As this subject is of considerable interest to engineers and especially those confronted with various boiler-room repairs, I wish to contribute a few lines.

In conformity with the rules of the Steam Boiler and Flywheel Service Bureau adopted by the Division of Boiler Inspection in the State of New York patches in the shell of a boiler are absolutely prohibited, regardless of the size of such patches. Welding of cracks either by the autogenous process or the electric arc in the shell of a boiler regardless of direction will not be permitted unless such welding is for the purpose of securing tightness and the stresses on the parts are fully cared for by properly riveted-on patches or straps placed over the weld. The plates at the end of the joints may be welded together for tightness provided the straps or other construction is ample to care for the stresses on the parts welded. It appears to me that the proper way of repairing a blister as small as that described by Mr. Nagle would be to heat it and drive the sheet back to its original position.

Of course autogenous or electric arc welding of reasonable length in a staybolted surface can be permitted, so that should the weld fail, the parts would be held together by the stays. The railroad shops made use of this method for a number of years, but are getting away from it lately. From the report of the Chief Inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission, I quote:

> While some of the boiler explosions were primarily due to low water, it is believed that their violence and consequent results were greatly increased by failure of crown sheets that had been welded together by the autogenous process. The failure of such seams, which have come into extensive use during the last few years, in some cases occurred with slight overheating. Investigation of these accidents indicated that the failure of the welds occurred with a higher level of water in the boiler and consequently a lower temperature in the sheet than in others where the crown sheets failed and did not tear.

Many authorities have been on the job, and much has been written about welding in boilers or pressure vessels in general. On one subject all seem to agree, namely, to avoid welding where overheating and failure are likely to occur and that welding should not be used where the strength of the structure is dependent upon the weld, nor where the strain to which the structure is subjected is not carried by other construction, nor in any part of a boiler wholly in tension while under working conditions.

Wide variation in the chemical composition of the metals and the fact that welders usually are neither chemists, metallurgists nor electrical engineers and know nothing about the relative contents of the various metals or their heat temperature necessary for fusion, are chiefly responsible for the many failures of welds on record.

If a weld of any kind is to be made, it is always well to consult the proper authority in charge of the work, that a study may be made of the metals to be welded together to secure the proper electrodes and the correct heat value which should be used to produce proper fusion and a perfect joint.

Albany, N. Y. ALBERT SMITH, Engineer,
Columbia Casualty Co.

Preventing Sparking at Brushes

There have been a number of comments published recently on what causes black spots on commutators and sparking at the brushes. An experience that I had some time ago along this line may be of interest. A 125-volt shunt-wound exciter rated at 60 amperes developed a bad case of sparking, and after trying all the usual remedies that may be applied while the machine was in operation, I failed to get any encouraging results, When the machine was shut down, the commutator was very hot. After it had cooled off, I spaced the brushes equally, sandpapered them to a good fit and

cleared up the commutator, hoping that the trouble had been remedied. However, the next day, when the machine was put into service, it soon developed sparking as badly as on the previous day. In fact conditions got so bad that it was almost impossible to hold the voltage on the alternator with both field rheostats cut out of circuit.

As a last resort I decided to put some lubricating oil on the commutator. This was applied by soaking a piece of cheesecloth in engine oil and holding it on the commutator while the machine was running under load. The burned oil smoke that came from that commutator left a feeling that I had a trouble on my hands that was as bad as any of the other evils. In two or three minutes the smoke cleared away and the sparking had disappeared to a considerable extent. A second oil bath caused the sparking to cease entirely, and the machine cooled down to normal temperature with the voltage back to normal.

I have had no trouble since. There are no signs of sparking at any of the brushes, and there is a nice chocolate glaze on the commutator. Every morning after starting up I slightly moisten a piece of cloth with oil and hold it lightly on the commutator for a few seconds, and the machine requires no more attention during the day.

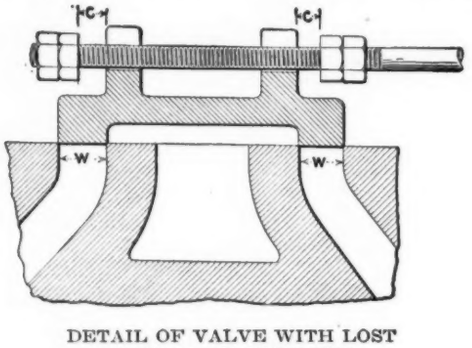
PHILIP BUMPUS.

Attleboro Falls, Mass.

Lost Motion Adjustment of Duplex Pump

In the Jan. 2 issue a reader asks the question, How is the length of stroke of a duplex pump adjusted? From experience and observation I have gathered a few points that might be of interest to other readers.

Referring to the cut, (1) the valve is symmetrical without lap or lead; (2) for an exhaust opening equal



DETAIL OF VALVE WITH LOST MOTION ADJUSTMENT

to the port width the steam opening must also equal the port width; (3) the valve travel should be twice the port width or equal to $2W$. If it is greater than $2W$, there is unnecessary motion and live steam may possibly blow through to the exhaust if the bridge is narrow. If the travel is less than $2W$, there will be a restriction of steam and exhaust openings, with a consequent sluggish movement of the pump. (4) Port width W plus lost motion C equals one-half the valve-stem travel. Therefore, in order to get a valve travel equal to $2W$, the lost motion C allowed on either side should be one-half the valve-stem travel minus port width W. This can be measured on the pump, and no guesswork will be necessary in setting the nuts on the rod that actuates the valve. (5) Increase in the lost motion C, due to wear or other causes, will reduce the opening to steam and exhaust and may cause the pump to act sluggishly. (6) Decreasing the lost motion not only insures maximum port openings, but it reduces the phase angle between the two plungers; that is, the trailing plunger may follow one-half stroke instead of a full stroke behind the leading plunger. (7) The amount of lost motion does not affect the cutoff in the cylinders. With no lost motion at all each piston would have time to complete its stroke before the other piston could change its valve setting. (8) The piston is brought to rest at the end of the stroke not by valve action, but by cushioning its exhaust. When a pump is running slowly on heavy loads, it requires little cushioning to equalize the unbalanced pressure; when running fast on light loads there is usually a little knock unless cushion valves are provided.

New York City. A. R. SMITH.

Putting Alternators Into Service After Excitation Has Been Lost

Replying to the inquiry of H. G. Ingalls on "Getting Units Back in Service Safely after an Interruption," in the Jan. 30 issue, where load is kicked off the system on account of losing excitation or other causes, in my opinion, one of the safest and best methods to get units back into service after the load has been lost is to clear the bus and switchboard and begin anew.

Get one machine tied in on the system and parallel the others afterward. Looking at this method from an imaginary point of view, it may seem to take longer than is necessary, but usually it is the safest and quickest after all. Where two or more units are running in parallel, they are held in synchronism by the generators, and if of different capacities, they rarely keep at synchronous speed when the load is dropped off by losing the field, as the speed-control regulator on the governors is seldom adjusted in proportion to the generator capacities when carrying load. Therefore, the units will get out of step at no load when field excitation is lost, and also the emergency controlling the overspeed of the turbine may trip one or more of the units off the line.

Therefore, things are pretty well mixed up to start out with and if false moves are to be avoided and unnecessary delays are to be prevented it will, in most cases, be found best practice to begin restoring service with all machines disconnected from the busbars.

When an exciter breaker trips out from some cause other than an overload, the operator, if standing close by, may be able to recover the service safely by closing the breaker immediately, as a cross-current is set up in the generators and keeps them in step for a few moments, provided the load on the generators is light. If the system and machines were carrying a heavy load and field were restored in this way, one might expect damage to the apparatus such as transformer units, etc. The charging current through the transformers at this time is as dangerous as a short-circuit, since it is intensified from the secondary side.

Another method of restoring service quickly, and one that works out well, is to separate the units by running them on separate buses, paralleling them again after normal conditions are restored.

Philadelphia, Pa. WILLIAM TOMPKINS.

In answer to the article on page 183 by Mr. Ingalls, I will relate our method of picking up a load.

Our plant has two turbines and three engine-driven units. All are 2,300-volt three-phase 60-cycle machines. Our regular exciter is motor-generator driven from the

main busbars. This is connected to all generators by a Tirrill regulator. In addition we have a steam-driven exciter. In case the entire load is lost, we get the steam-driven exciter under way, connect the Tirrill regulator to it and to one of the main units. Of course it would be necessary to drop part of the load. It is assumed that with the whole load gone the overspeed governors will act on the turbines or engines. After one main unit is on the board, the regulator can be switched over on to that machine and the motor-generator set started, thereby permitting closing down the steam-driven exciter. Then the other machines are paralleled as needed and full load picked up in the usual way.

I believe that any plant should have a relief steam-operated exciter set for just such an emergency. As far as good practice is concerned, I say that any way of getting the load back in the shortest time is good practice. Of course, good judgment must be exercised if false moves are to be avoided and delay prevented in getting the machines in service again.

Rochester, N. Y. R. G. SUMMERS.

Should Steam for Heating and Process Be Charged to Power-Plant Costs?

In the Jan. 16 issue Mr. Maconnell asks the question "Should steam for the heating and process be charged to power-plant cost? He also asks for information on the proper distribution of power cost. Steam used for this work could be charged to power-plant cost, but it should be credited to the plant, for such work, and not charged to the generation of electricity.

Perhaps the company by which Mr. Maconnell is employed is not concerned about the unit cost of the parts or of the operations necessary to produce their manufactured product. A great many of the manufacturers today are figuring their production costs on the cost of the various operations or prices. It would be evident from Mr. Maconnell's article that everything in the power line was charged against the power. The 3,000 lb. of steam used in process work is as much a necessity to their finished product as any of the material entering into it, and it would seem to be the proper method to so charge it. While this live steam is used in process work, it does not in anyway enter into the generation of electric power. Since the sale of the finished product produces the revenue from which all expenses and profits are paid, it may not seem necessary to the owners, to institute a cost system where these different processes and operations may be separated into their respective costs.

The 7,000 lb. of steam used per hour for heating may be treated as a separate item, either as a byproduct if exhaust steam is used, or as a direct product if live steam is used. This heating is, of course, necessary to the manufacture of the product, inasmuch as it affects the working conditions. I have found it a good plan to keep a record of coal used by the different processes and if possible meter the live steam used for process or heating. This frequentlty comes in handy to show the increase in cost of operation for these items. I presume from the description of the plant given by Mr. Maconnell that it is operated condensing and exhaust steam is not available for heating. The heating by live steam under the present system would add to the cost of generating power in the proportion of heating to power requirements.

The cost of the current furnished to the employees is practically taken care of by the return from the flat rate of 50c. a week. It is plain that it should not be a charge against the power plant. Undoubtedly, Mr. Maconnell is in the same environment as many other engineers, in that any expense that is not placed where it belongs, as against production cost, will be dumped against power costs.

If Mr. Maconnell has any means of separating the amounts of steam used for power, process and heating, he can satisfy himself (and maybe his firm) that he has an efficient plant.

In finding the total cost of generating steam the costs can be itemized as follows:

Interest, depreciation, taxes and insurance	
Water, plant only	
Labor, chief engineer and assistants	
Labor, firemen (regular)	
Labor, extra	
Coal	
Ash removal	
Cylinder oil	
Machine oil	
Special oil	
Grease	
Waste	
Packing	
Boiler compound	
Lamps, plant only	
Recording charts	
Repairs	
Various items and small charges	
Total	

By dividing the total cost by the amount of steam generated the cost per 1,000 lb. of water evaporated can be determined, and this will give a practical method of finding the unit, or total cost, for the various processes in which the steam is used. If there is not any way of metering the steam flow from the boilers, if the boiler-feed water is metered and a deduction made for blowing down, a fairly good check can be made on the steam generated; from this subtract the steam used in process and heating or any other than generating power, and it will leave the amount of steam used in the plant. This amount may run higher than the water rate given by the turbine manufacturers, but it will include the steam used by the auxiliaries, which belong to the cost of generation.

Total cost of generating steam divided by thousands of pounds evaporated	=	Unit Cost per 1,000 lb. of steam (or water) evaporated
Steam to process work, meter reading in 1,000 lb. steam × unit cost	=	Cost of process steam
Steam to heating, meter reading in 1,000 lb. steam × unit cost	=	Cost of heating
Credit to plant, cost of current sold to employees	=	Credit lighting

Total charges outside of the cost of generating electricity by the plant are the cost of process work, plus cost of heating, and equal the deduction, to be made from the total cost of operation, to find the generating cost. The cost of generating divided by the output in kilowatt-hours during the same period as covered the costs, would give the rate per kilowatt-hour. The item of current sold to the employees should be made a credit to the plant; this bill can be added to total cost, then a credit taken for the amount received from the employees. Evidently, part of the time the current is supplied by the company's own plant and no way is provided to know what part is furnished by the plant or city service. It shows a small loss unless the balance of current is used in plant or manufacturing departments, which cost should be charged in its proper place. A better way would be that this bill should not be added to total cost but should be a charge and credit to a separate account, leaving the profit or loss to be applied to the cost of operation of the plant. M. E. GUILE.

Binghamton, N. Y.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Chimney Draft

What produces draft of a chimney and what does the amount of draft depend on? W. L. A.

The draft produced by a chimney is caused by the difference in weight of the gases inside the chimney and the weight of the outside air. The chimney gases have a higher temperature and are lighter, and the lighter gases rise and cold air flows in to take their place. If cold air is heated as it enters a chimney, there will be a continuous current of cold air flowing to replace the heated air that is discharged. Since the draft in a chimney is produced by the difference of weight between the column of heated gases inside of the chimney and the air outside, the draft will be greater with a high temperature inside or with a tall chimney. The draft pressure is proportional to the temperature inside (measured from absolute zero), and the velocity is in proportion to the square root of the height of the chimney.

Additional Coal Required for Heating by Exhaust

What would be a fair amount of coal to be charged for the additional amount burned in ten hours for raising the temperature of 50,000 lb. of water per hour from 150 to 160 deg. F. in a hot-water heating system, where the heating is performed by the exhaust of a non-condensing engine? The steam taken by the engine is at 125 lb. boiler pressure and the feed-water temperature is 175 deg. F. W. L. N.

When the heating is performed by exhaust, the additional coal required for generating the steam supplied to the engine depends on the present coal consumption per pound of m.e.p. developed by the engine, and the additional number of pounds increase of the average back pressure. For all practical purposes it may be assumed that for a moderate variation of m.e.p. the steam consumption would be in proportion and, for an increase of average back pressure, the steam consumption and coal required would be increased in the same ratio that the increase of average back pressure bears to the original m.e.p.

As an example, suppose the present coal consumption for generation of steam used by the engine is 14,000 lb. per 10 hours, and the m.e.p. during 10 hours is 45 lb. Then, for 1 lb. increase of the average back pressure, the coal consumption would be increased $\frac{1}{45}$ of 14,000 = 311 lb. of coal for 10 hours.

The value of the service is the same as if the heating were performed by live steam. The coal required for that kind of service would depend on the heat value of the coal and per cent of efficiency of the boiler and heater. There would be delivery of 50,000 × (160 — 150) = 500,000 B.t.u. per hour and, with coal having a heat value of 13,000 B.t.u. per pound and an over-all efficiency of 60 per cent, the heating would require 500,000 ÷ (13,000 × 0.60) = about 64 lb. of coal per hour, or 640 lb. of coal per ten hous.

Weight of Steam Flowing at Stated Velocity

What would be the formula to determine the number of pounds of steam flowing per hour through a 6-in. pipe at the velocity of 3,000 ft. per min. with the density of the steam such as to have a volume of 3.73 cu.ft. per pound? G. S.

The weight of steam flowing per minute would be the volume passing a given point in the pipe per minute, divided by the volume per pound. Calling d the diameter of the pipe in inches, its cross-sectional area in square feet would be, $d \times d \times 0.7854 \div 144$ or $0.005454\ d^2$ sq.ft., and calling l the velocity in feet per minute, the volume of steam passing a point in the pipe per minute would be $d^2\ 0.005454 \times l$ or $0.005454\ d^2\ l$ cu.ft. Hence if D represents number of cubic feet of the steam per pound, the total weight W flowing per minute is given by the formula.

$$W = d^2\ l\ 0.005454 \div D.$$

In the example, $d = 6$, $l = 3{,}000$ and $D = 3.73$.
Substituting these values the formula becomes

$$W = 6 \times 6 \times 3{,}000 \times 0.005454 \div 3.73 = 157.9$$

lb. per minute

Operating a 110-Volt Direct Current Motor on a 220-Volt Circuit

Can a ¼-hp., 110-volt direct-current motor be operated on a 220-volt circuit? Is there any means of stepping down the 220 volts to 110? W. B. G.

If the load were constant on the motor, it would be possible to connect a resistance in series with the machine to reduce the voltage to the proper value at the motor terminals. On a shunt machine it will be necessary to connect a resistance in series with the armature and another in series with the field coils. The resistance in series with the armature will depend upon the load on the motor. At full load the current will be about 2 amperes, and under this condition the necessary resistance to connect in series with the armature will equal 110 ÷ 2 = 55 ohms. The resistance to be connected in series with the field coils will depend somewhat on the design of the motor, but a 25-watt 110-volt lamp should be sufficient. It should be understood that this arrangement is only a makeshift and, unless the load is constant, the speed will vary inversely as the load. At no load the speed will be practically double that at full load. If the motor is designed for a comparatively slow speed, it may be possible to con-

nect a resistance in series with the field winding only and operate the armature directly on 220 volts and at double the speed for 110 volts.

There is no way of stepping the 220 volts down to 110 except with a motor-generator set, which in this case is impracticable. The cost is so small that the most satisfactory solution to the problem will be to rewind the machine, using wire of one-half the cross-section now used and double the number of turns in the coils.

Efficiency of Butt and Double Strap Joint, Triple Riveted

What would be the efficiency of a triple-riveted butt and double-strap joint in which the tensile strength of plate is 55,000 lb. per sq.in.; thickness of plate, $\frac{1}{2}$ in.; thickness of butt straps, $\frac{7}{16}$ in.; pitch of rivets in outer row, $7\frac{3}{4}$ in.; and diameter of rivet holes, $\frac{7}{8}$ in.? J. M.

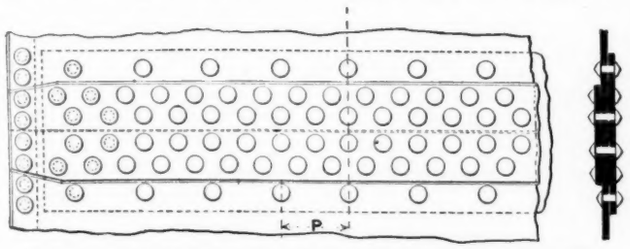
Having tensile strength of plate = 55,000 lb.; thickness of plate $\frac{1}{2} = 0.5$ in.; thickness of butt straps $\frac{7}{16} = 0.4375$ in.; pitch of rivets in the outer row $7\frac{3}{4} = 7.75$ in., being twice the pitch of rivets in the second and inner rows; diameter of rivet holes $\frac{7}{8} = 0.875$ in., giving the cross-sectional area of a rivet = $(0.875)^2 \times 0.7854 = 0.6013$ sq.in., and assuming the strength of a rivet in single shear = 44,000 lb. per sq.in. and in double shear = 88,000 lb. per sq.in.; and also assuming the crushing strength of plate = 95,000 lb. per sq.in., projected area, then for a length of the joint equal to a unit of pitch indicated by the dimension P in the sketch:—

(1) Strength of solid plate = $7.75 \times 0.5 \times 55{,}000 = 213{,}125$ lb.

(2) Strength of plate between rivet holes in an outer row = $(7.75 - 0.875)\ 0.5 \times 55{,}000 = 189{,}063$ lb.

(3) Shearing strength of four (4) rivets in double shear, plus the shearing strength of one (1) rivet in single shear = $(4 \times 88{,}000 \times 0.613) + (1 \times 44{,}000 \times 0.6013) = 238{,}115$ lb.

(4) Strength of plate between rivet holes in the second row, plus the shearing strength of one (1) rivet in single shear in the outer row = $(7.75 - (2 \times 0.875))\ 0.5 \times 55{,}000 + (1 \times 44{,}000 \times 0.6013) = 191{,}457$.



BUTT AND DOUBLE-STRAP JOINT, TRIPLE RIVETED

(5) Strength of plate between rivet holes in the second row, plus the crushing strength of inside butt strap in front of one (1) rivet in the outer row = $[(7.75 - (2 \times 0.875))\ 0.5 \times 55{,}000] + (1 \times 0.875 \times 0.4375 \times 95{,}000) = 201{,}367$ lb.

(6) Crushing strength of plate in front of four (4) rivets, plus the crushing strength of inside butt strap in front of one (1) rivet = $(4 \times 0.875 \times 0.5 \times 95{,}000) + (1 \times 0.875 \times 0.4375 \times 95{,}000) = 202{,}617$ lb.

(7) Crushing strength of plate in front of four (4) rivets, plus the shearing strength of one (1) rivet in single shear = $(4 \times 0.875 \times 0.5 \times 95{,}000) + 1 \times 44{,}000 \times 0.6013 = 192{,}707$ lb.

The least strength for a unit length of joint P in the sketch, is derived from consideration (2) namely, 189,063 lb. and as according to (1) the strength of the solid plate for the same unit length of joint would be 213,125 lb., the efficiency of the joint would be $189{,}063 \div 213{,}125 = 0.887$ or $88\frac{7}{10}$ per cent.

Formula for Finding Radius of Bumped Head

What is the formula for determining the radius of a spherically bumped head? R. G. A.

In the figure if

R = The radius of the spherical portion of the head,

d = The length of a cord subtending any spherical section of the head,

H = The height to which the head is bumped as measured from the middle point of d, perpendicular to the spherical surface,

then,

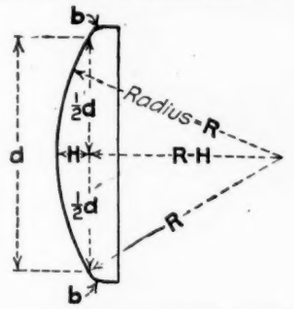
or,

$$R^2 + \left(\frac{d}{2}\right)^2 + (R - H^2),$$

$$2RH = \frac{d^2}{4} + H^2$$

from which,

$$R = \frac{d^2}{8H} + \frac{H}{2}$$



DETERMINING RADIUS OF BUMPED HEAD

The measurement d should be taken well within the bend at b in the flange; otherwise the measurement H may be too large for use in the formula, which applies only to a true spherical section subtended by d.

Changing Heater Connections

In our plant, which is operated condensing, the boiler-feed pumps take their supply from a steel tank which receives the returns from the heating system and drips from traps and also the city water supply controlled by a float valve. The feed pumps discharge through a closed heater set in the engine exhaust pipe between the low-pressure cylinder and the condenser. From this heater the water is discharged at about 85 deg. F. to another closed heater through which the feed pumps and condenser pumps exhaust and in which the feed water is heated above 200 deg. F. Would it be advisable to pass the city water through the closed heater on the engine exhaust and then through the float valve in the tank, for pumping direct to the second heater, or would that make the water too hot to be handled by the feed pumps, especially when the engine is operated non-condensing? J. B.

There should be no difficulty in handling the hot water by the feed pumps, but the proposed change does not seem to be warranted unless operating non-condensing is practiced considerably, and with low temperature of feed water discharged from the second heater. By admitting the city water to the heater connected with the engine exhaust, this heater would be of only little greater assistance to operation of the condenser in receiving city water before it has become warmed by returns from the traps and the heating system, and the small gain for condensing purposes probably would be offset by greater losses from radiation and evaporation from the receiving tank.

Easy Lessons in Engineering

How to Figure Volumes

If the rectangular body, shown at *A* in Fig. 1, were split into one-inch cubes, there would be three layers of 24 cubes each, or a total of 24 × 3 = 72 cubes. The total volume of 72 cu.in. may be looked upon either as the product of the three dimensions or as the top area times the height.

The second is the more useful point of view, because it applies to the many other shapes that are classed as "cylinders." The word "cylinder" is here used in its broadest sense to mean any figure that could conceivably be cut out with a bandsaw. Under this general head come the shapes shown at *A*, *B*, *C*, *D*, *E*, *F*, *G* and *H*. All these are "right" cylinders, that is, the sheet from which they were "sawed" had parallel sides and the "saw blade" was set square to the "saw table."

In each one of these cases the volume is the top area times the height. This is best seen by considering the irregular cylinder *B* which has a top area of 39 sq.in. and a height of 3 in. Evidently, each one-inch layer contains 39 cu.in, so the total volume must be 39 × 3 = 117 cu.in. In the same way the first step in getting the volume of *C*, *D*, *E*, *F*, *G* or *H* is to figure the top, or cross-sectional, area by the methods shown in the previous lesson. This multiplied by the height gives the volume.

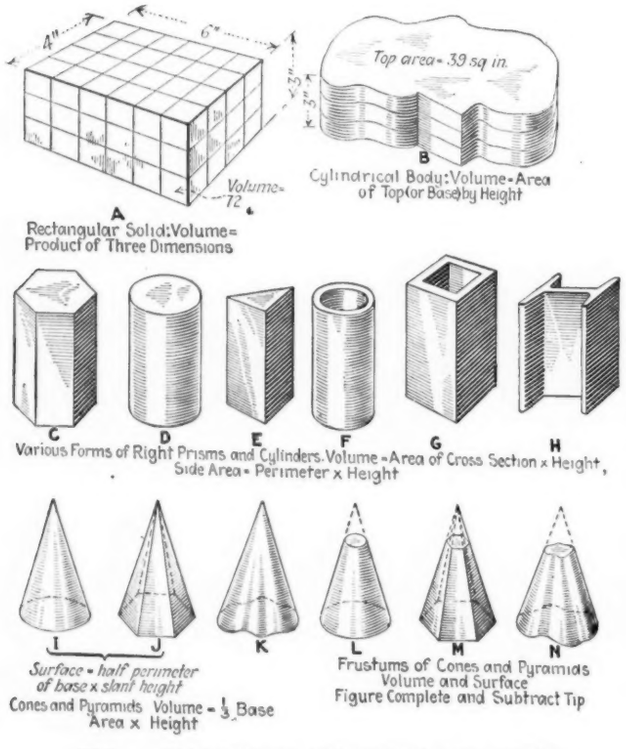


FIG. 1—VOLUMES OF CYLINDERS AND CONES

The word "cone," like the word "cylinder," may be used in a general sense. It then refers to the solid obtained by running a bunch of straight lines from any point to the perimeter (edge) of any area. As particular examples, an ordinary circular cone is shown at *I*, a regular pyramid at *J* and an irregular cone at *K*. No matter what the shape of a cone, its volume is one-third that of a cylinder with the same base and height, or ⅓ × area of base × height (measured square with the base).

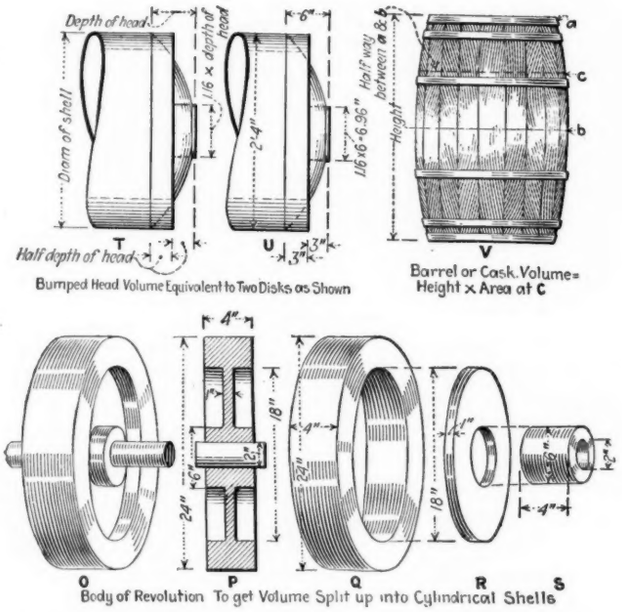


FIG. 2—VOLUMES OF BUMPED HEADS, CASKS, ETC.

Fig. 2 shows how to handle other special shapes. *T* illustrates an easy and accurate method of getting the volume of a tank with a bumped head. First, figure the volume of the straight shell, assuming that it extends to a point halfway out on the head. To this add the volume of a disk whose thickness is half the depth of the head and whose diameter is 1.16 times the depth of the head. In *U*, for example, extend the length of the straight shell 3 in. and then add to its volume that of a disk 3 in. thick and 1.16 × 6 = 6.96 in. in diameter. A method of getting the approximate volume of a cask is shown at *V*.

The expression "body of revolution" is a mathematical way of saying "a shape that could be turned on a lathe." Such bodies can be split into cylinders and cones. For example, the flywheel *O* can be separated into three cylindrical rings, the volumes of which can be easily figured.

A. I. E. E. Holds Joint Meeting in Chicago and New York

During the three days, Feb. 14 to 16, the American Institute of Electrical Engineers held one of its most successful midwinter conventions in the Engineering Societies Building. New York City. The total registration was about 1,500, and about 500 members and guests attended the dinner dance held in the Hotel Astor on Friday evening. On Thursday evening a smoker was held under the auspices of the New York Section on the fifth floor of the Societies Building and proved to be a very enjoyable affair for the 700 members and guests in attendance. One of the features of the event was a demonstration of the Palophotophone by C. A. Hoxie. This apparatus records by a new method speeches, music, etc., on a moving-picture film, from which they may be reproduced. A number of inspection trips were arranged, among them a visit to the offices and plant of the McGraw-Hill Co., publishers of *Power* and other engineering journals, where delegates and guests to the convention were entertained at luncheon on Thursday noon.

At the seven technical sessions thirty-three papers were presented and discussed. Most of these are of a highly technical nature and with the exception of one, "Application and Limitation of Thermocouples for Measuring Temperature," are not of general interest to *Power* readers. An abstract from the paper on thermocouples will appear in an early issue.

One of the outstanding features of the Convention was the joint session with Chicago on Wednesday evening, presided over by President Frank B. Jewett. At this meeting two-way loud-speaking telephone installations were used at each city, so that the two audiences heard all the proceedings of the joint meeting. In addition the proceedings of both meetings were broadcasted. There were over 1,000 in attendance at the two meetings. President Jewett addressing the joint meeting said in part:

We can hardly picture the limits of the effects and influences which will flow from the developments of electric science which have made this night possible. In truth, we are participants in a historical event and our children, nay even many of us, may see the agency we here use employed with mighty effects in controlling our collective relations in state and nation.

Someone has said that the greatest political engine ever devised was the colonial town meeting, where every question of importance was debated and discussed in the open forum of all the citizens. Be that as it may, we are well aware that our best government today is found in those small political units where the town meeting in some form is feasible and still persists. It is only when we come to the larger units of city, state and nation that the limitations of common discussion of vital matters, which are imposed by sheer physical size, evidence themselves in cumbersome and inadequate substitutes for personal discussion and ofttimes in unsatisfactory results.

May it not be that in this two-way working telephone, with its sensitive transmitters and loud-speaking receivers, we have the instrumentality for insuring a simpler and better ordering of our affairs—an instrumentality which will enable us to derive many of the benefits of the town meeting in the greater concerns of our national life? The mechanism which we are here using is one adapted to permit many speakers in many distant audiences to be heard by all who care to listen and take part in a common discussion.

In voicing the opinion that this mechanism is destined profoundly to affect our political and economic machinery, I intend to convey no thought or picture of a pure democracy, but only of a representative form of government in which all questions that would be helped by oral discussion can be so discussed without restraint from the physical limitations of the human voice or of distance. They might be discussions between widely separated groups on some matter of common concern or between a designated representative and his constituents. We have here the successful realization of a dream dating back to the pioneer days of Bell himself; namely, the production of a loud-speaking telephone which would reproduce the human voice in stentorian tones and in many places simultaneously.

We lack only direct distant vision to make this joint meeting one in very fact save only for the element of the personal proximity of those in attendance, and who among us is hardy enough to believe that this last limitation may not be removed within the lifetime of many of those now here? Fundamental and applied research are opening new doors daily in bewildering succession. When they open that last door which now prevents man from exercising at a distance all his powers of personal intimate communication, we will have another noteworthy meeting of this Institute.

Tonight, however, we must be content with full powers of speech and hearing but with partially defective vision. So it comes about that you, Mr. Schuchardt, our vice-president in Chicago, and you, Mr. Rhodes, my vice-chairman, are each in a unique position, a position in which one of you is acting in place of the president at a meeting where the president himself is in attendance in his official capacity, and the other is acting similarly for the president in his capacity as presiding officer. Some day this may not be necessary, but for the moment we are really acting as the eyes of this great joint meeting and are transferring as best we can the functions of distant vision by means of human speech.

Factors in Cooling-Tower Design*

In the design of a cooling tower the main objects are, first, to obtain the actual heat abstraction, and second, to retain the cooling water in the system. The temperature of the wet-bulb thermometer indicates the lowest temperature to which the water can be cooled. From experience it has been established that an approach to within five degrees of the wet-bulb thermometer, where the latter varies from 65 to 75 deg., can be obtained readily, and where the wet-bulb temperature ranges from 75 to 80 deg. and above, an approach to within three degrees of the wet-bulb temperature is feasible.

Three Main Types of Cooling Tower

Cooling towers are made up in three main types: First, the fan type, consisting of a closed system containing the cooling surface over which the water passes and through which air is forced or drawn so as to bring the latter in contact with the former. On account of the great amount of power required to operate the fan this system receives consideration only where the space available is limited.

Second, natural-draft towers are similar, with the exception that the air is drawn through the tower by the action of gravity. That is, the air is heated in passing up through the tower, causing an upward current of air, the velocity depending upon the temperature of the water entering the tower and the outside atmospheric conditions. This type of tower is rarely used except in large installations where the vapor from an atmospheric type of tower would prove objectionable.

The natural-draft tower cannot produce the required amount of air movement to reduce the temperature of the water to a sufficiently low point. Unfortunately, the lower the temperature of the water entering the tower, the slower the air currents and, consequently, the smaller the capacity of the tower. To handle a large quantity of water, this type of tower would have to be of extraordinary size, entirely outside of the limits of economy.

The third type referred to is the so-called atmospheric tower, which is open on all sides, permitting the air to blow in and out at will. This tower also takes advantage of the gravity action due to the heated air, so that when there is no wind movement, it acts practically like a natural-draft tower. Unless this tower is properly closed in, a large quantity of water is lost due to the action of the wind, and the stronger the wind the greater the loss.

Various means for overcoming this difficulty have been tried. With the old style of wooden slats it is impossible to prevent water from blowing through. Extending the sides at an angle of 45 deg., for a distance of 2 to 4 ft., in the nature of inclined wings, has been tried. While this system is more efficient than the wooden slats, still when the wind reaches a certain velocity, any water that lodges on the wings is pushed up on the surface and continues until it reaches the outside where it is blown off into the surrounding space.

The system devised by the writer consists of a series of louvers extending all around the tower and spaced at fixed

*Abstract of paper read before the Chicago Section of the American Society of Refrigerating Engineers, Jan. 30, 1923, by Edwin Burhorn, of the Edwin Burhorn Co., New York City.

distances vertically center to center. The bottom of each louver is formed in the shape of a trough, and the top of the louver on the outside is formed in the shape of a deep curve. When the water is blown out on this louver, the wind pushes it along to the outside until it hits the curve. It then tries to follow along the curve, but in order to get out it must run against the action of the wind. The water therefore rolls back toward the bottom of the louver, where it accumulates and gradually flows back into the tower system at each end through openings provided for this discharge.

Taking care of the water in this way prevents the louvers' slopping, one over the other, keeps the passage free for air and prevents a heavy gust of wind picking up a considerable quantity of water and hurling it out of the tower.

In conjunction with the louver system the water distribution in the tower is another important point to consider. The water must be distributed so that it will flow through the tower uniformly regardless of the wind velocity; that is, there must be some way of rectifying the tendency of the wind to blow the water to the leeward side of the tower. In towers where this is not provided for, the water is blown to the leeward from deck to deck until, finally, at the lower part of the tower it has collected in large quantities at that side of the tower.

Water Distribution an Important Point

To avoid this tendency, the author devised a system consisting of a series of parallel troughs, the troughs in each deck running at right angles to the troughs in adjacent decks. These troughs are spaced at proper intervals so that the water overflows uniformly throughout the area of the tower. Where the wind blows the water slightly to one side in one deck, it is brought back by gravity action in the troughs below, so that no matter which way the wind may blow, there is always this rectification taking place. Thus the distribution is practically uniform so that the maximum amount of water surface is exposed to the maximum air movement prevailing.

A cooling system used in connection with refrigeration or steam condensing should be designed to cool the water to within five degrees, at least, of the wet-bulb thermometer, whereas if the water were to be used for gas engines, air compressors or in similar work, a low final temperature would not be so important.

In refrigeration and steam condensing the condenser pressure is based on the temperature of the water leaving the condenser, and that being the case, it is desirable to keep the water temperature leaving the condenser as low as possible. In either case the total work consists of removing a definite amount of heat in a certain time, which is the product of the quantity of water by the range of temperature. By doubling the quantity of water, the range of cooling could be halved. Were it not for the increased cost of pumping, large piping, etc., it would be more economical to cool at a low range. Under present conditions the economical range of cooling seems to be about ten degrees. This necessitates the circulation of about 3 gallons of water per minute per ton of refrigeration and, in connection with steam condensing outfits, the circulation of about 90 lb. of water per pound of steam.

Physical Dimensions

The physical dimensions of a tower depend on so many variables that it is impossible to give a formula that would apply to all cases. On general principles the height should be as low as possible, as this will not only reduce the pumping cost, but also the load due to wind pressure and thus lessen the cost of the foundation.

In actual practice the height of atmospheric towers varies from about 12 to 50 ft. or more. Fan-type towers are usually about 30 ft. high, whereas natural-draft towers are 75 ft. or more high, depending on the draft desired. The proper height depends in the first place on the interior design of the cooling tower and in the second place on the area of the cooling tower. The area is dependent almost entirely on the details of the interior arrangement of the cooling surface in combination with the means adopted for preventing the water from blowing out of the tower.

In cooling towers of about 300 gal. per min. capacity, the area allowed is about one square foot per gallon per minute circulated, and on larger towers, the area is increased 50 to 100 per cent, depending upon the arrangement of the cooling surface. With the proper arrangement of cooling surface and louver system, the height of tower for a 10-deg. range should not be greater than 15 ft. Where the range of cooling increases, higher towers are used provided the area is not increased. The exact variation cannot be formulated, as these details are entirely a matter of experience.

Control of Boiler and Economizer Corrosion

Since this paper is concerned only with corrosion, it is possible to eliminate consideration of priming, foaming and scaling. Scaling and corrosion are sharply differentiated in that, with a single exception, one rarely accompanies the other. This exception is in the case of scales consisting mainly of silicates. Such scales amalgamate with the boiler wall, destroy its smoothness and remove a film of metal when detached. This corrosion effect is primarily mechanical. Aside from silicate scale, boiler scale is an excellent preservative coating, as far as corrosion is concerned, although decidedly objectionable in other respects.

Corrosion is a chemical reaction between the metal of the boiler and one or several of the constituents of the boiler water. There are several theories—the electrolytic theory, the carbonic-acid theory and the more recent colloidal theory—but they are all founded upon approximately the same major premises, although they differ greatly in detail. Fortunately, these premises cover practically all observations that are of interest to an engineer and make the problem comparatively simple from the viewpoint of chemistry. Certain molecules of water are broken up into pairs of "ions," the hydrogen ions and the hydroxide ions, the former consisting of an atom of hydrogen with a "plus" electrical charge and the latter containing one atom each of oxygen and hydrogen with a negative charge. Iron is able to displace hydrogen ions from solution. The hydrogen gas is deposited on the surface, while the iron goes into solution.

The concentration of hydrogen ions is a measure of the "acidity" or acid quality of a solution. With water the concentration of hydrogen ion is inversely proportional to that of the hydroxide ion. It is impossible to increase one without at the same time decreasing the other. Increasing the hydrogen-ion concentration increases the acidity and hence the corrosion. This accords with experience. Increasing the number of hydroxide ions has the opposite effect. These facts furnish the theoretical groundwork for several observations of a practical nature.

Alkalinity or causticity of a boiler water is usually associated with softening either by the zeolite or by the lime-soda process. As ordinarily understood, alkalinity is due to the addition of soda ash (sodium carbonate), while causticity is due to the addition of caustic soda (sodium hydroxide). Where either sodium carbonate or sodium hydroxide is fed directly to the boiler, the choice between the two is primarily an arbitrary matter.

In general the addition of either caustic soda or soda ash decreases the corrosion, by decreasing the acidity, or concentration of hydrogen ions. This, however, is a broad statement which requires some reservations. It is true, in spite of the chemical logic, that relatively pure waters made slightly alkaline by the addition of soda ash are more corrosive than the water in its original state. On general grounds, therefore, the addition of caustic soda is to be recommended in preference to the addition of sodium carbonate. This, however, is not an invariable rule.

The addition of caustic soda or soda ash to boilers operating on distilled water produces practically no benefits. With raw feed water the addition of sodium in either of the two forms mentioned is much more beneficial, but much depends upon the nature of the other totally dissolved salts.

From the electrolytic point of view the order of corrosion,

*Abstract of paper delivered before the Boston Section of the A.S.M.E., Jan. 11, 1923, by J. R. McDermet, Research Engineer, Elliott Company.

due to soluble and ionized salts in boiler water, is as follows: Nitrates, chlorides, sulphates, chromates and arsenates. The nitrates are comparatively rare. With chloride waters soda ash is perhaps more useful than caustic soda, but this is open to dispute. Where the impurities are chiefly sulphates, with magnesium present, high causticity is almost a complete preventive of corrosion.

It is possible to summarize the conclusions in the foregoing paragraphs by saying that causticity or the addition of caustic soda serves best with impure natural waters containing considerable quantities of dissolved solids.

There is still to be considered the bugaboo of operating engineers—caustic embrittlement of the boiler metal where there is a high concentration of hydroxides in the water. This has been a real and serious difficulty in certain cases, either from industrial pollution or in certain localities where the underground water is heavily charged with soda ash. This is not a corrosion effect, but embrittlement due to penetration of the gases into the metal. Caustic embrittlement is still so mysterious, and its occurrence has been so comparatively rare, that no definite explanation can be offered.

How Dissolved Oxygen Influences Corrosion

The second factor influencing corrosion is dissolved gases, and in particular dissolved oxygen. The normal solution of iron by water has natural limits. These are so low that, if other factors did not enter in, the amount of metal dissolved would not be appreciable in the lifetime of a boiler. As has already been stated, when iron goes into solution, hydrogen is deposited on the metal. This deposit polarizes the metal surface and would bring the reaction to a stop if the hydrogen were not promptly destroyed by dissolved oxygen in the water. The dissolved oxygen has another effect. The corrosion product, which is ferrous hydroxide (a combination of iron, hydrogen and oxygen) is soluble in water. The dissolved oxygen turns this into an insoluble compound (ferric hydroxide) of the same elements. Since the rate of corrosion is limited by the amount of the corrosion product dissolved in the water, this casting out of the product in insoluble form permits the corrosion to continue. In other words, although oxygen does not directly cause corrosion, corrosion cannot ordinarily proceed to any appreciable extent without its presence.

If pipes heavily corroded from previous oxygen contamination are fed with air-free water, the product of the previous corrosion is to some extent reduced to soluble compounds so that the rust is loosened. In this way a pipe choked with corrosive products may be partly cleaned out. This is a big operating advantage in connection with the use of deaërated water in hot-water sanitary systems, where pipe stoppage from corrosion products is a formidable factor.

The upper limit of dissolved oxygen at which some control of the form of the corrosion products is first exercised is about 0.6c.c. of oxygen per liter. Definite pitting, however, has been experienced with boiler waters of continuous oxygen content as low as 0.15 c.c. per liter. Corrosion has not been experienced with waters that have been deaërated and have values substantially zero to a trace, a trace being defined as less than 0.025 c.c. per liter.

To sum up, dissolved-gas removal with pure waters prevents corrosion, while with acid waters having a high concentration of hydrogen ion, it suppresses it. It cannot prevent the attack due to the acid pollution, but it can very definitely prevent any regenerative action. Neither can the removal of dissolved gases prevent the pitting of defective material, whose various components are so segregated as to produce electrolytic couples. Commercial boiler materials have, however, proved sufficiently pure to avoid this objection. Aside from these, oxygen removal is more useful than causticity in that it aims directly at the seat of the trouble. Addition of caustic soda protects only the boiler; the economizer is included only when the caustic feed is continuous, as with 100-per cent makeup.

The separation of dissolved gases is better than caustic treatment in all but one respect, namely, that the latter is cheaper and requires no apparatus, while deaërating equipment is expensive.

American Boiler Manufacturers' Association Meets

The winter meeting of the American Boiler Manufacturers' Association was held at the Hotel Astor, New York City, on Monday, Feb. 12, the president, A. G. Pratt, of the Babcock & Wilcox Co., presiding.

After a brief address by the president, the roll of the active and associate members was called by H. N. Covell, the secretary. He reported that the association now has a membership of 77 active and 22 associate member companies and one honorary member.

E. R. Fish, representative of the association on the Boiler Code Committee of the A.S.M.E., reported on the work of that body. A letter from Charles E. Gorton, chairman of the Uniform Boiler Law Society, was read, reporting the progress of boiler legislation in several states.

W. C. Connelly reported for the Committee on Related Industries and said that the manufacturers of superheaters and economizers were now associate members of the association and it was recommended that these manufacturers be represented on the committee. The recommendation was also made that some action be taken to have the manufacturers of stokers and fans become associate members.

G. S. Barnum, of the Bigelow Co., read a paper on "Budgeting" and emphasized the value of an accurate method of cost accounting to the manufacturer.

Mr. Connelly reported on the questionnaire relative to the rating of boilers on square feet of heating surface versus horsepower and said that this questionnaire had been submitted to the entire membership of the association. About 45 replies were received; of these 7 preferred to rate the boilers by horsepower, 24 by square feet of heating surface and 11 by both heating surface and horsepower. The manufacturers of water-tube boilers were the only ones to present a unity of opinion on the use of 10 square feet per horsepower; the others varied from 7.5 to 12, the greatest difference being in the small sizes of locomotive and vertical type boilers. On the question of including integral economizer surface as part of the boiler-heating surface, 19 firms favored treating this as a separate item, while 4 considered that it should be treated as boiler-heating surface.

Mr. Back read the report of the joint committee with Smoke Prevention Association on setting height of horizontal-return-tubular boilers. It was decided by a vote of the members present that the minimum heights as adopted at the June meeting last year should stand, and it was recommended that some action be taken in co-operation with the Smoke Prevention Committee to arrive at some standard height of setting satisfactory to both parties.

Joseph F. Scott, chairman, and C. O. Myers, secretary of the National Board of Boiler and Pressure Vessel Inspectors, told of the work and progress of that organization and said that the reduction in fees charged had resulted in a material increase in membership and that the board was now practically self-supporting.

A. G. Pratt told of the conference with the Department of Commerce on "Standardization and Simplification," and F. G. Cox spoke on the "Standardization of Bolt, Nut and Rivet Proportions."

In a Western plant, where there are installed three 1,800-kva. 3,600 r.p.m. horizontal turbo-generators, considerable trouble was experienced with the bearings. This was especially noticeable in its action upon both the lubricating oil and the bearings themselves. Upon investigation it was learned that there existed a considerable passage of induced electric current from the shaft of the turbine, through the bearings to the machine frame and thence to ground. The passage of this current tended to pit the shaft and bearings and affect the lubricating oil in the bearings, thereby breaking it down and producing acids, etc. After some study of the problem a small device, consisting of two graphite carbon brushes in a suitable brush-holder, was attached to the end of the frame so that the brushes rubbed against a circular brass button screwed into the end of the shaft. This device remedied the trouble.

News in the Field of Power

Sesqui-Centennial Plans

Further Details of Philadelphia's 1926 Exposition to Mark Fifty Years of Progress

ANNOUNCING an exposition of quality rather than of quantity, depending upon ideas and ideals rather than upon the amount of money spent, the Sesqui-Centennial Exhibition Association has made known plans for the Sesqui-Centennial Exhibition to be held in Philadelphia in 1926, opening on April 30 and closing on Nov. 13.

The plans for the exhibition have been considered exhaustively by able architects and engineers and by men who have had wide experience in connection with previous expositions. The association in charge states that the exhibition will be held under the combined auspices of the President and Congress, the Governor and Legislature of Pennsylvania and the Mayor and Council of Philadelphia. Its threefold purpose is to mark the 150th anniversary of the signing of the Declaration of Independence, to portray the progress of the world, particularly in the fifty years since the Centennial Exhibition held in Philadelphia in 1876, and to create a closer understanding between the peoples of the world.

As shown on the map, the site chosen lies in Fairmount Park northwest of the center of the city. The grounds will begin on the Parkway at a point east of the Art Museum and extend into the park, occupying an area ample for an attendance of more than a million a day.

Among the exhibition buildings there will be Halls of Commerce and Industry, in which the progress of the last fifty years will be dramatized by contrast; for example, the original Corliss engine in direct contrast with the modern turbine; the locomotive of 1876 and the electrically driven machine of 1926, the hand-plow of 1876 and the tractor of 1926, and so on. There will be also an Electrical Palace filled with the wonders of electricity, a great Airplane Building with an airdrome for exhibition purposes, an Automobile Hall and a Palace of the Press that will show the growth of the modern newspaper and periodical, and constitute a news center for visiting representatives of the press of the world, and for the issuing of a daily paper for the exhibition.

Adequate provision will be made for showing the marvelous national progress in agriculture, mining, fisheries, transportation and shipping. In these exhibits the co-operation of the United States Department of Agriculture, the Bureau of Mines and the Bureau of Fisheries will be enlisted.

Between the buildings will be gardens, lagoons, paths and roadways, and suitable facilities for easily moving about. A single concourse will accommodate hundreds of thousands gathered to listen to the President and other distinguished speakers, and to witness ceremonies, pageants and electrical or fireworks displays.

SITE OF PHILADELPHIA SESQUI-CENTENNIAL EXHIBITION, 1926

Map of northwestern part of city, showing the Fairmount Park-Parkway site recommended by the Sesqui-Centennial Committee of the Engineers Club of Philadelphia and accepted by the Exhibition Association.

An Engineering Congress

Whether there will be separate buildings for the individual states, group buildings, or a single Hall of States, is a question yet to be settled. In connection with the exhibition there will be numerous congresses, notably the International Engineering Congress already mentioned in these columns. Opportunities will be provided for conventions of patriotic societies, business associations, fraternities and national and international organizations.

The motion picture will be well represented. With Philadelphia's historic buildings in the background each day's presentation of a great motion picture will be prefaced by a film portraying the signing of the Declaration of Independence and other great events of the Republic that will bring the lessons of American history home to the minds of millions of people.

The comparative efficiencies of various makes and types of air cleaners for tractor motors have been determined recently by the Agricultural Engineering Division of the University of California. A bulletin is now being prepared describing the construction of the testing apparatus, methods of preparing the standard dust used in the tests, description of the various kinds of tests made on the cleaners, together with the results obtained. Those wishing a copy of this bulletin should write to the Agricultural Experiment Station,

High-Dam Case Hangs Fire

Northern States Power Co. Is the Favored Contender for Mississippi Power

ADVICES from St. Paul are to the effect that the Minnesota legislature is not likely to adopt the bill authorizing the Municipal Electrical Corp. or the City of Minneapolis, or both, to issue bonds to put in the power project at the High Dam on the Mississippi. The Mayor of Minneapolis states that he is not opposing the acquiring of rights by one private interest as against another but believes the license for this development should be placed in public hands so that it may exercise the control which goes with ownership of the power.

Apparently a majority of the members of the legislature feel that the placing of a power business amounting to $1,000,000 a year at the disposition of a city council which changes each two years, would not make for economical operation and would result in costly power to the consumer.

The Federal Power Commission will not act in this matter until the legislature takes definite action or adjourns without having taken action. It will then determine promptly, it is believed, who have shall the license. It would be a question of determining whether it should go to the Northern States Power Co. or to Henry Ford.

There is no great amount of uncertainty as to the course that the Power Commission will take. The water-power act itself designates the use of power for public-utility purposes as a higher use than private manufacture. The Northern States Power Co. is fully equipped to make the most economical and practical use of this power. It is recognized that there will be no small amount of pressure brought in the interest of Mr. Ford, but since power is such a small factor in his contemplated operation in St. Paul—less than one per cent of his costs—there is a very generally held opinion that the license will go to the Northern States Power Co.

South Carolina Cannot Have Columbia Canal

Restoration of the title to the Columbia Canal to the State of South Carolina from the Columbia Railway, Gas & Electric Co., which uses it for hydro-electric purposes, was denied by the United States Supreme Court in a decision rendered Feb. 19.

Title to this canal was vested by the State in the penitentiary board in 1887, with the proviso that the canal be extended to Gervies Street within two years or not more than seven on penalty of forfeiture, and eventually extended to the Congaree River. A later act permitted sale to a private corporation, with the stipulation that 1,500 hp. be furnished free to the State, the City of Columbia and an individual. The Columbia Railway, Gas & Electric Co., acquired title from this grant. In 1917, the legislature passed a bill for recovery of the canal by the State on the ground that the canal had not been extended to the river. The State Supreme Court sustained this act and declared the canal forfeited for non-performance of contract.

The United States Supreme Court, in reversing this decision, declared that as there was no penalty clause attached to the original act as to extension to the river, and as other conditions have been met, the South Carolina act of 1917 was unconstitutional and that title to the canal is property vested in the Columbia Railway, Gas & Electric Co.

Varied Program for A.S.M.E. Regional Meeting

A lecture and demonstration of the 100-in. telescope at the Mt. Wilson Solar Observatory will be an interesting technical feature of the Pacific Coast Regional Meeting of the A.S.M.E., to be held in Los Angeles, April 16-18. The ten-mile motor trip to the top of Mt. Wilson will take the visitors up 6,000 ft. through some of southern California's most beautiful mountain country.

The technical session on Monday morning, April 16, promises some interesting papers, particularly those on hydro-electric development in California, on flow meters for viscous fluids and on centrifugal pumps. In the afternoon one of the Hollywood motion picture studios will be inspected, in connection with which there will be a talk on "Engineering Work in the Motion Picture Industry." The tentative program for the meeting has been announced as follows:

MONDAY, APRIL 16

Morning—Registration. Technical session: "Hydro-electric Development of Southern California Edison Co.," illustrated; "Hydro-electric Development of State of California," illustrated; "Flow Meters for Viscous Fluids," and "Centrifugal Pumps."

Afternoon—Visit motion picture studio in Hollywood. (Ladies invited.) Talks on "Engineering Work in the Motion-Picture Industry."

Evening—Visit one of the large motion-picture theaters.

TUESDAY

Morning—Motor trip to Pasadena. 10:00 a.m. California Institute of Technology, Pasadena, Cal.—Inspection and Demonstration in Physics Laboratory.

Afternoon—Lunch—Vista del Arroyo Hotel, Pasadena. Laboratory of Mount Wilson Solar Observatory, Pasadena. Motor trip to top of Mt. Wilson (6,000 ft. elevation). (Ladies invited.)

Evening—Dinner at Mt. Wilson Hotel. Lecture and demonstration of 100-inch telescope. Spend night on Mt. Wilson.

WEDNESDAY

Morning—Leave Mt. Wilson for Long Beach by motor via oil fields of Santa Fe Springs and Signal Hill. Lunch at Long Beach, Hotel Virginia.

Afternoon—Mission Play at San Gabriel.

Evening—Banquet, Los Angeles.

Recommend Reorganization of Federal Executive Departments

President and Cabinet Recommend Changes Needed for Greater Efficiency

SWEEPING changes in the organization of the Executive Departments of the American Government are embodied in the reorganization plans approved on Feb. 16 by the President, and submitted to the Joint Congressional Committee. The outstanding recommendations are: (1) The co-ordination of the Military and Naval Establishments under a single Cabinet officer as the Department of National Defense. (2) The transfer of all non-military functions from the War and Navy Departments to civilian departments, chiefly Interior and Commerce. (3) The establishment of one new department, the Department of Education and Welfare. (4) The change of the name of the Post-Office Department to Department of Communications. (5) The elimination of all non-fiscal functions from the Treasury Department.

Among the more important of these changes are the transfer of the functions of the Federal Power Commission, now an independent establishment, to the Department of the Interior. The transfer of the Bureau of Mines and the Patent Office to the Department of Commerce, and the addition of a bureau to the newly named Department of Communications to develop and extend telephone and telegraphic communications, including radio, for the general public benefit. The Department of the Interior is given two major functions: The administration of the public domain and the construction and maintenance of public works. The Department of Commerce is charged with the promotion of industry and trade, and the development, regulation and protection of the merchant marine.

The newly created Department of Education and Welfare will have, if the plans go through, four major subdivisions—education, health, social service and veteran relief—each in charge of an efficient secretary. Among the existing bureaus and officers to be transferred to this new department are the Bureau of Education, the Indian School, the Bureau of Pensions, the Public Health Service, the Smithsonian Institution, and the Federal Board for Vocational Education.

The United States Coal Commission, because of its judicial character, and the fact that it is performing a service for all branches of the Government, remains an independent establishment, as do the Civil Service Commission, the Interstate Commerce Commission, the Federal Trades Commission, the Government Printing Office, the Bureau of the Budget, and others.

The reorganization plan was recommended by the President and the Cabinet at the request of the Joint Committee on Reorganization, whose chairman is Walter F. Brown, and whose personnel includes Senators Smoot of Utah, Wadsworth of New York, Harrison of Mississippi, and Representatives Webster of Washington, Temple of Pennsylvania, and Moore of Virginia.

Personal Mention

Arthur Vincent has been appointed mechanical engineer for the new Federal Reserve Bank Building, New York City.

Theodore B. Parker, formerly assistant hydraulic engineer for the Electric Bond & Share Co. and the Utah Power & Light Co., has entered the hydraulic division of Stone & Webster, Inc., Boston, Mass.

Robert McKinney, for the last fifteen years superintendent of the Hudson Valley Railway & Power Co., has resigned and will shortly become associated with the Hudson Coal Co., Scranton, Pa., as superintendent of motive power.

Society Affairs

Boston Section, A.S.M.E., will hold a meeting conducted by junior members at 7:45 p.m. on March 1 at Pierce Hall, Harvard University. A buffet supper will be served at 6:15 p.m. The subject of the meeting will be "Broader Opportunities for the Engineer." The speakers will include Charles T. Main, past president of the A.S.M.E., and J. G. Callan, industrial engineer and professor at the Harvard Graduate School of Business Administration.

New Haven Branch, A.S.M.E., will be entertained by the student branch at Yale University on Feb. 28. There will be three speakers from the Sheffield Scientific School and movies of Langley Field bombing experiments will be shown.

Metropolitan Section, A.S.M.E., will meet on Feb. 27 at the Imperial Restaurant, 360 Fulton St., Brooklyn, at 8 p.m., following a dinner at 6:30 p.m. at the same place. P. W. Swain, assistant editor of *Power,* will outline the whole subject of "Feed-Water Treatment" in a three-quarter-hour paper, to be followed by a discussion in which it is expected that makers and users of the various types of equipment will bring out points not covered fully in the paper.

Business Notes

The General Electric Co. has discontinued the name "Sprague Electric Works" in referring to its electrical manufacturing plant in Bloomfield, N. J., which will be known simply as the company's Bloomfield plant.

The General Electric Co. has just paid $1,100,000 in supplementary compensation to employees who have been with the company for five years or more. The payment was made in G-E employees' 7-per cent investment bonds, in $10 units or multiples.

The Combustion Engineering Corp., New York City, has appointed T. J. Cleary, Room 702 Candler Bldg., Atlanta, Ga., as its southern agent.

The Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, Pa., has appointed C. A. Anderson, Jr., general sales manager, to succeed James D. Robertson, who resigned on account of ill health. Mr. Anderson was formerly district manager at the Philadelphia office.

The Byllesby Engineering and Management Corp. has elected Halford Erickson, R. G. Hunt, Joseph H. Briggs, B. W. Lynch and M. A. Morrison as vice-presidents of the organization.

Frank Toomey, Inc., Philadelphia, Pa., has placed J. W. Timmons in charge of its steam and electrical departments to succeed James A. Condon, who resigned to enter business for himself. Mr. Timmons comes from the Robbins & Myers Co., Philadelphia, previous to which connection he had been fourteen years with the Toomey company.

James A. Condon, Inc., has taken over the business formerly conducted by Howard W. Read at Third and Arch Sts., Philadelphia. The new company, specializing in steam, electrical and contractors' equipment, is headed by James A. Condon, who was with Frank Toomey, Inc., for 21 years. Mr. Read will continue to have his office at the same address.

The Standard Conveyor Co., North St. Paul, Minn., has acquired all rights to the well-known "Brown Portable" line of portable and sectional piling, elevating, conveying, loading and unloading machinery. These products will continue to be maufactured at the plant of the Brown Portable Conveying Machinery Co. at North Chicago, Ill.

The Western Electric Co. has appointed G. E. Cullinan as general sales manager. Mr. Cullinan entered the employ of the company upon his graduation from Williams College in 1901, and for several years was connected with the New York house. He was manager of the St. Louis office from 1909 to 1918, when he went to Chicago as central district manager.

Coming Meetings

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual conventions and exhibitions of the State Associations scheduled as follows:

Kansas, at Fort Scott, Apr. 4-6; C. H. Taylor, 517½ W. 6th St., Topeka.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Pacific coast regional meeting at Los Angeles, Apr. 16-18; spring meeting at Montreal, Canada, May 28-31.

Society of Industrial Engineers; George C. Dent, 327 S. La Salle St., Chicago, Ill. Spring convention at Cincinnati, Ohio, Apr. 18-20.

American Welding Society, 29 W. 39th St., New York City. Annual meeting at New York City, April 27-28.

American Association of Engineers, 63 East Adams St., Chicago, Ill. Annual convention at Norfolk, Va., May 7-9.

American Water Works Association, 153 W. 71st St., New York City. Annual meeting at Detroit, Mich., May 21-25.

National Electric Light Association; M. H. Aylesworth, 29 West 39th St., New York City. Annual meeting at New York City, June 4-8.

Electric Power Club; S. N. Clarkson, Kirby Bldg., Cleveland, Ohio. Annual meeting at Hot Springs, Va., June 11-14.

American Institute of Electrical Engineers, 29 W. 39th St., New York City. Annual convention at Swampscott, Mass., June 25-29.

American Society for Testing Materials; C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 25-30.

Trade Catalogs

Feed-Water Treatment — H.S.B.W.-Cochrane Corp., Philadelphia, Pa. Publication 1112, describing briefly all the Cochrane apparatus for measuring, heating and treating boiler-feed water.

Monolithic Wall Construction—Keystone Refractories Co., 120 Liberty St., New York City. Pamphlet describing a method of building monolithic furnace walls with crushed old firebrick and "Dura-Stix."

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Feb. 12 1923	Feb. 19 1923
Pool 1,	New York	$5.00–5.50	$4.50–5.15
Smokeless,	Columbus	4.50–5.00	4.25–4.50
Clearfield,	Boston	3.50–4.25	3.50–4.25
Somerset,	Boston	3.75–4.50	3.75–4.50
Kanawha,	Columbus	2.50–2.75	2.50–2.75
Hocking,	Columbus	2.40–2.65	2.40–2.65
Pittsburgh No. 8	Cleveland	3.15–3.20	3.15–3.25
Franklin, Ill.,	Chicago	3.75–4.00	3.25–3.50
Central, Ill.,	Chicago	2.50–2.75	2.50–3.75
Ind 4th Vein,	Chicago	3.00–3.25	3.00–3.25
West Ky.,	Louisville	2.25–2.50	1.85–2.25
S. E. Ky.,	Louisville	2.25–3.00	2.25–3 00
Big Seam,	Birmingham	2.25–2.50	2.00–2.25

FUEL OIL

(f.o.b. city unless otherwise specifie)

New York—Feb. 21, Port Arthur light oil, 22@25 deg. Baumè, 4⅞c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago — Feb. 16, 24@26 deg. Baumè, $2.02 per bbl.; 32@36 deg., $2.39 per bbl. in tank cars.

Philadelphia—Feb. 19, 26@28 deg. Baumè, Oklahoma, $1@$1.05 per bbl.; 30@34 deg., Oklahoma (group 3), 3¼@3⅜c. per gal.; 16@20 deg. Seaboard, $1.50@$1.60 per bbl.

St. Louis—Feb. 12, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2 per bbl.; 30@36 deg., gas oil, $2.15 per bbl.; 36@40 deg., distillate, $2.25 per bbl.

Pittsburgh—Feb. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.; 34 deg., neutral, 8c. per gal.

Dallas—Feb. 17, f.o.b. local refinery, 26@30 deg., $1.43 per bbl.

New Plant Construction

PROPOSED WORK

Ala., Birmingham—R. E. Boggs, Jefferson County Bank Bldg., (machinery, etc.), is in the market for a C. E. 7½ Sullivan mining machine, complete on trucks; two complete rock crushing plants, 400 ton per day each, with boilers, engine, etc.; one ¾ yd. steam shovel on caterpillar tread.

Ariz., Tucson—The Clk. of Bd. Educ., c/o Lyman & Place, Archts., 79 North Stone Ave., will receive bids until Mar. 5 for the construction of a 2 story high school. Estimated cost $750,000. Separate bids will be asked for forced draft heating system, furnace heat, refrigeration machine and various motors. Noted Dec. 7.

Ark., Piggott—The city will receive bids until Mar. 2 for drilling two deep wells and casing same complete. A. C. Moore, 221 West 3rd St., Joplin, Mo., Engr. Bids will be received later for pumping equipment, laying of water mains and construction of tower, tank and power house.

Calif., Los Angeles — The St. Vincent's Hospital Assoc. is having plans prepared for the construction of a group of hospital buildings. Cost to exceed $1,000,000. J. C. Austin, Baker-Detwiler Bldg., Archt.

Calif., Oakland—The State Dept. of Pub. Wks., Div. of Architecture, Sacramento, received bids for the construction of employees' cottage, women's shop building, power house and recreation building for Industrial Home for Adult Blind, here, from F. W. Maurice, 1362 East 22nd St., Oakland, $45,760; A. H. Vogt, 185 Stevenson St., San Francisco, $46,113; E. T. Leiter & Sons, 3601 West St., Piedmont, $47,867. G. B. McDougall, Forum Bldg., Sacramento, State Archt. Noted Feb. 6.

Calif., Oroville—The Oroville-Wyandotte Irrigation District will soon receive bids for the construction of Lost Creek Dam, Jorgensen constant angle arch type, 112 ft. high, 480 ft. long on top radius, 40 ft. long on bottom, 6 ft. wide at top, 23½ ft. wide at bottom, concrete, including sluice gates, headgates for flumes, rights of way and road changes. Estimated cost $150,000. S. J. Norris, Oroville, Engr.

Calif., San Diego—J. D. Spreckels, Coronado, is having plan prepared for the construction of a 7 story annex to hotel on State St. Estimated cost $350,000. W. H. Wheeler, 302 Spreckels Bldg., Archt. Equipment detail not reported.

Calif., San Francisco — The city and county of San Francisco plans to build a war memorial, including opera house, conservatory of music, dramatic club, club house for Amer. Legion and art museum on 4 blocks bounded by McAllister, Grove, Franklin and Van Ness Aves. Cost will exceed $2,500,000. Engineer or architect not selected.

Calif., San Francisco—W. F. Gunnison, Archt., 57 Post St., is preparing plans for the construction of a 10 story apartment building, to contain ten 6 room apartments with garage quarters, on Hyde St. near Lombard St. Owner's name withheld. Equipment detail not reported.

Calif., San Francisco—The Pacific Gas & Electric Co., W. E. Creed, Pres., 445 Sutter St., plans the construction of 5 electrical sub-stations. Estimated cost $1,000,000. Owner's Engineering Dept., Engrs.

Calif., San Francisco—Pope & Talbot, 3 and Berry Sts., are having plans prepared for the construction of a 2 story market terminal, to have 1,700 ft. frontage, on Second, Third, King and Berry Sts. Estimated cost $2,000,000. First unit to be constructed now to cost $500,000. C. A. Muessdorffer, Humboldt Bank Bldg., Archt.

Calif., San Mateo—The Market St. Ry. Co., 58 Sutter St., San Francisco, has had estimates made for the construction of extensions to its system, $603,500; sub-station $30,000, here. Engineer not announced.

Calif., San Pedro — The Pacific Coast Borax Co. is having plans prepared for the construction of a 1 and 2 story machine shop, boiler house and generating plant. Cost will exceed $75,000. A. C. Martin, 430 Higgins Bldg., Los Angeles, Archt.

Calif., Stockton — The city, c/o A. L. Banks, Clk., will receive bids until March 20, for the construction of an auditorium on Center, Oak, Fremont and Commercial Sts. Estimated cost $500,000. City Architectural Comn. (L. S. Stone, G. Allen and W. J. Wright, 41 South Sutter St.) Archts. Equipment detail not reported. Noted May 23, 1922.

Col., Ashcroft (Aspen P. O.)—The Belle Marie Mining & Milling Co., Aspen, plans the construction of mill buildings, power house, shops, etc., including mining machinery. Estimated cost $500,000. A. J. Peteling, 428 Grand Ave., Milwaukee, Wis. Archts. and Engrs.

Conn., Bristol—The Bristol Hospital, F. F. Barnes, Pres., plans to build a 3 story hospital. Estimated cost $300,000. Engineer or architect not announced.

Fla., Jacksonville—Sobel & Rothschild, 824 West Bay St., is in the market for a 150 hp. Scotch Marine boiler and a 25 hp. locomotive type boiler.

Fla., Tampa—A. B. Hale is having plans prepared for the construction of a 35 ton ice and cold storage plant on North Rome and Fuller Sts. Estimated cost $50,000. Private plans.

Ga., Culverton—G. P. Moore is in the market for a 60 hp. boiler and a 50 hp. engine.

Ga., Davidsboro — The W. B. Warthon Produce Co. is in the market for ice manufacturing machinery and cold storage equipment.

Ill., Chicago—Halperin & Braun, Archts., 19 South La Salle St., are preparing plans for the construction of a 10 story, 200 x 300 ft. apartment hotel, including steam heating system, on Sheridan Rd. near Grace St. Estimated cost $5,000,000. Owner's name withheld.

Ill., Gridley—The village of Gridley will receive bids until March 6, for one deep well pump and one 15 hp. oil engine. Taylor & Woltman, Bloomington, Engrs.

Ill., South Chicago—E. E. Hall, Archt., 123 West Madison St., is receiving bids for the construction of a 4 and 5 story, 125 x 149 ft. hospital, including steam heating system, on 11th and Perry Sts. for the South End Hospital Assn., 11212 South Michigan Ave. Estimated cost $300,000. Noted Feb. 6.

Ind., New Albany—The National Hame & Chain Co. plans to rebuild its factory, part of which was destroyed by fire. Owner is in the market for machine shop and power house equipment. Engineer or architect not announced.

Ia., Des Moines—W. Lister, 702 Youngerman Bldg., is in the market for one vertical steam engine, 5 x 6 in. or not larger than 5 x 7½ in. (used); one vacuum pump, 5½ x 8 x 7 in. or not larger than 8 x 8 x 12 in.; one firebox boiler not less than 50 hp. and not more than 80 hp., capable of carrying 100 lb. pressure (might consider tubular boiler); one feed pump.

Kan., Independence—The city plans the construction of a sewerage disposal plant, including pumping plant, filters and sprinklers. Estimated cost $75,000. H. W. Crawford, Engr.

Kan., Newton—The Shaw Cycle Co., 221 Main St., is in the market for an automatic air compressor.

Kan., Wichita—The McCormick-Armstrong Press, Market and Williams Sts., is having plans prepared for the construction of a 2 story, 120 x 140 ft. printing plant. Estimated cost $100,000. Lorenz, Schmidt & Co., 516 4th Natl. Bank Bldg., Archts. The owner is in the market for electric motors, conveying apparatus and other equipment.

La., Baton Rouge—The Greater Agricultural College has had plans prepared and will soon reecive bids for the construction of a 2 story main engineering building and a 2 story Agricultural College building, 330 ft. long, with 3 wings, 250 ft. long. Estimated cost $2,000,000 and $3,000,000 respectively. T. Link, Greater Agricultural College, State Archt.

Md., Baltimore—The Baltimore Properties Co., c/o A. D. Le Esperance, Cambridge Apartments, is having plans prepared for the construction of a 4 story community building, including stores, offices, market, theatre, hotel and roof garden, on Maryland and North Aves. Estimated cost $1,750,000. B. H. Prack, Keystone Bldg., Pittsburgh, Pa., Archt. Equipment detail not reported.

Mass., Boston—The Edison Electric Illuminating Co., 70 State St., is having preliminary plans prepared for the construction of a power distributing station on Warrenton and Carrol Sts., to connect with generating station in South Boston. Stone Webster, Inc., 147 Milk St., Archts. and Engrs.

Mass., Springfield—The Commercial Trust Co., 226 Main St., plans to build an 8 story bank and office building. Cost between $300,000 and $500,000. Engineer or architect not chosen.

Mich., Holland—The Boone Bros., Holland Hotel, plan the construction of 5 story, 150 x 150 hotel, including steam heating system. Estimated cost $250,000. G. S. Kingsley, 109 North Dearborn St., Archt.

Mich., Pontiac—The Fisher Body Corp., General Motors Bldg., Detroit, is having preliminary plans prepared for the construction of an automobile body plant to consist of two 1 story and one 2 story units, 150 x 500 ft., with dry kilns and detached power plant on Baldwin Ave., here. Estimated cost $2,000,000. A. Kahn, 1000 Marquette Bldg., Detroit, Archt.

Minn., St. Paul—R. B. Whitacre & Co., Inc., 205 South Robert St., is in the market for a 100 kw. direct connected engine and generator, 125 volt d.c. Give make and state whether engine is center or side crank and condition of units.

Minn., Slayton—The city will receive bids until March 5, for one deep well pump, two-plunger, belt driven, for 8 in. well, 90 in. two-plunger steel rods, minimum capacity 120 gal. per minute against head of 200 ft.

Minn., Willmar—The city invited bids on engineering services in preparing preliminary plans for municipal power plant. H. Gunderson, City Clk.

Miss., Oxford—The Bd. Mayor and Aldermen of the city will receive bids until March 15 for engine, generator and switchboard equipment for the municipal water and light plant. Proposals will be considered for either oil engine or steam engine equipment.

Mo., Hollister—The Empire Dist. Electric Co., Forsyth, has had preliminary plans prepared for the construction of a power dam on White River about 3½ miles northwest of here, to be 175 ft. high, 1,500 ft. long and impound waters of lakes with 500 miles of shore line. Later the company plans to build a large power plant. Estimated cost $15,000,000.

Mo., St. Louis—W. L. Ems, 9 West 10th St., (machine shop), is in the market for a water boiler, 220 gal. capacity.

N. Y., Buffalo—The Cleveland & Buffalo Coal Co., 1224 Prudential Bldg., M. G. Siener, Pres., is in the market for a portable coal conveyor, electrically operated, for unloading and loading coal for proposed yard at 60 Marion St.

N. Y., Cortland—The Bd. Educ. will receive bids until Mar. 10 for the construction of a high school. Estimated cost $400,000. G. W. Conable, 45 West 24th St., New York, Engr. and Archt. Noted May 16.

N. Y., Jamestown—The New Ice & Coal Co., 148 Buffalo St., is in the market for ice manufacturing machinery and equipment for plant on Clinton St.

N. Y., Rochester—J. C. Schutz, 1370 Main St., Buffalo, is in the market for ice making machinery and equipment for plant here.

N. D., Casselton—The city, C. D. Smith, City Auditor, will receive bids until Mar. 7 for the construction of a waterworks system, consisting of 1,815 ft. of 4 in., 32,-140 ft. of 6 in. and 2,490 ft. of 8 in. cast iron pipe; seventy-five 5 in. hydrants; three 4 in. hydrants; standpipe; pump house; fire pump. C. L. Pillsbury Co., 1200 2nd Ave., Minneapolis, Minn., Engr.

Ohio, Cincinnati—Rendigs, Panzer & Martin, Archts., Lincoln Inn Court Bldg., will soon award the contract for the construction of a 10 story, 100 x 200 ft. office building on Court and Main Sts., for the

Union Savings Bank & Trust Co., Union Trust Bldg. Estimated cost $500,000. Equipment detail not reported. Noted Oct. 17.

Ohio, Columbus—The Rainbow Tire & Rubber Co., Southern Hotel, C. E. Ross, Pres., is in the market for three rubber mills, one 250 hp. engine, two 500 hp. boilers, two crushers, two washers, four vulcanizing machines and several special presses for plant at Delaware.

Ohio, Columbus—The Homeopathic Hospital Corp. has purchased a 45 acre site and is having plans prepared for the construction of 12 or 14 buildings, including general hospital building, administration building, sanitarium, factory for the manufacture of medicine, etc. Estimated cost $2,225,000. D. A. Carmichael, 67 East Long St., Columbus, Archt. Equipment detail not reported.

Okla., Wynnewood—The city, City Clk., will soon award the contract for the construction of a 100,000 gal. tank and tower, power plant, pipe lines, wells and electric distribution system, including two triplex pumps, two 350 hp. oil engine generator sets complete with switch boards. Estimated cost $85,000. V. V. Long & Co., 1300 Colcord St., Oklahoma City, Engrs. Noted Jan. 2.

Ore., Portland—The United Cigar Stores of America, 557 Howard Bldg., San Francisco, plans to build a 100 x 100 ft. office building on Washington St. and Bway, here. Estimated cost $2,000,000. Engineer or architect not announced.

Pa., Altoona—T. B. Baker, San Antonio, 6th Ave., is in the market for a 25 hp. electric motor.

Pa., Indiana—E. G. House is in the market for coal handling and conveying machinery, also equipment.

Pa., Oil City—The Penn-Amer. Refining Co., Rouseville, is having plans prepared for the construction of a 1 story, 45 x 60 ft. power house. Estimated cost $75,000. Rust Eng. Co., 311 Ross St., Pittsburgh, Engrs. The owner is in the market for equipment.

Pa., Phila.—Bayuk Bros., 1106 Montgomery Ave., manufacturer of cigars, is in the market for one blower; one air washer, capacity 10,000 cu.ft. per minute; 15 hp., 2 phase motor.

Pa., Williamsport—The Lycoming-Edison Co., West and Willow Sts., is in the market for power house generating equipment.

Tex., Dallas — M. Weiss, 903 Elm St. (machine shop), is in the market for a 100 hp. high pressure tubular boiler and a 500 hp. engine.

Tex., San Antonio—The School Bd. will receive bids until March 6 for the construction of five 1 and 2 story Junior High School buildings, including electric wiring, heating system, etc., on San Pedro and Mulberry Sts., Josephine St., Berkshire and Yorkshire Sts., Morales and Zarzamora Sts. and Darragh St. Estimated cost $800,000. W. E. Simpson & Co., Natl. Bank of Commerce Bldg., Engrs. Phelps & DeWees, Gunter Bldg., Archts. Noted July 4.

Tex., Hemphill—The Temple Lumber Co. plans to rebuild its lumber mill, including machine shops, power and tool house, recently destroyed by fire. Estimated cost $500,000. Private plans.

Wis., Markesan—The River View Canning Co., W. A. Miller, Pres., Farmers State Bank, is having plans prepared for the construction of a 3 story, 50 x 80 ft. canning factory and power house. Estimated cost $50,000. Private plans. The owner is in the market for canning and power machinery.

Wis., Milwaukee—The Louis Allis Co., J. M. Barr, Purch. Agt., 133 Stewart St., is in the market for an air compressor, approx. 75 ft. capacity.

Wis., Milwaukee—The Pittsburgh Plate Glass Co., L. Patton, Pres., 213 Lake St., is having preliminary plans prepared for the construction of a 60 x 60 ft. power plant, including boilers, generators, engines, stokers, etc. Estimated cost $200,000. Cahill & Douglas, 217 West Water St., Engrs.

Wis., Neenah—The Valley Paper Mills, 145 Wisconsin Ave., are having preliminary plans prepared for the construction of a 60 x 110 ft. power house in connection with paper mill being erected. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs. The owner is in the market for boilers, engines, generating unit, beaters, coal and ash handling machinery, mechanical stokers, sets, superheaters and two cranes.

Wis., Oshkosh — The Oshkosh Water Dept., A. C. McHenry, Mayor, is having plans prepared for the construction of 27 x 30 and 27 x 60 ft. additions to pumping station; two 10 in. pumps, capacity 10,000 gal. per day, each; one 8 in. pump, capacity 3,750 gal. per day, electrically operated. Estimated cost $80,000. W. A. Baehr, 122 South Michigan Ave., Chicago, Engr. J. Dreger, Oshkosh, Archt.

Wis., Waukesha — Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids on a steam-driven air compressor of 225 ft. capacity, for the White Rock Mineral Springs Co., 1702 White Rock Ave.

B. C., Point Grey—The Dept. of Public Wks., Provincial Parliament Bldgs., Victoria, will receive bids in about two months for the construction of 2 and 3 story temporary buildings, including two dormitories, power house, etc., here, for the University of British Columbia. Estimated cost $350,000. P. Philip, Dept. Public Wks., Victoria, Engr. H. Whittaker, Dept. Public Wks., Victoria, Archt. Noted Dec. 7.

Ont., Belleville—The City Council will soon receive bids for the construction of a steel intake pipe, gasoline driven motor supply water mains and a water purification plant. Estimated cost $300,000. Gore, Nasmith & Storrie, Continental Life Bldg., Toronto, Engrs.

Ont., Hamilton — The Hydro-Electric Comn. of Hamilton, City Hall, W. Ellis, Chn., plans the construction of a substation, equipment to include switches, switchboards, transformers, lightning arresters, bus bars and feeder lines, 110,000 volts. Estimated cost $100,000.

Ont., Lansing—The Twp. of North York, H. D. Goode, Clk., is having plans prepared for two hydro-electric areas preparatory to installing street lighting and power systems. Estimated cost $50,000. James, Proctor & Redfern, Excelsior Life Bldg., Toronto, Engrs.

Ont., Meaford—The town ratepayers, G. G. Albery, Clk., passed a bylaw for $65,000 for the construction of a hydro-electric transmission line and power system, including poles, wire, crossarms, transformers, etc.

Ont., Toronto—The city plans the construction of a duplicate water works plant, capacity 100,000,000 imperial gal. per day, including intake filters, chlorination apparatus, electric centrifugal pumps, domestic and fire pumps, reservoir, etc. Cost between $12,000,000 and $14,000,000. R. C. Harris, City Hall, Engr.

H. T., Honolulu — The Constructing Quartermaster will receive bids until April 12, for material and labor for installation of machinery and equipment in refrigerating plant to be erected at Schofield Barracks, Oahu.

CONTRACTS AWARDED

Calif., Long Beach—The Cooper Arms Bldg. Co., c/o Curlett & Beelman, Archts., Union Bank Bldg., Los Angeles, awarded the contract for the construction of a 12 story apartment building, on Ocean Ave., here, to the Scofield Eng. Co., Pacific Finance Bldg., Los Angeles. Estimated cost $1,000,000. Noted Aug. 8.

Fla., Orlando—R. E. Grabel and J. N. Wigfall, Jr., awarded the contract for the construction of a 4 story hotel, including steam heating system, on North Orange Ave., to G. A. Miller, 28 Petteway Bldg., Tampa. Estimated cost $412,000.

Ill., Chicago—E. Hall, Archt., 123 West Madison St., awarded the contract for the construction of an apartment hotel building on Stony Island Ave. and 67th St. to E. Bloom, 6711 Stony Island Ave. Estimated cost $3,500,000. Owner's name withheld. Equipment detail not reported.

Ill., Chicago—W. H. Mulholand, 30 North La Salle St., representing owner, awarded the contract for the construction of a 7 story, 62 x 160 ft. hotel, including steam heating system, at 5406 North Spaulding Ave. to the G. W. Caldwell & Son Co., 508 State Savings & Trust Bldg., Indianapolis, Ind. Estimated cost $500,000.

Ill., Chicago—H. Smith, c/o Rissman & Hirschfield, Archts., 139 North Clark St., awarded the contract for the construction of a 3 story apartment building on Central Park and Madison Sts., to the Douglas Constr. Co., 3939 West Adams St. Estimated cost $500,000. Steam heating system will be installed.

Ill., Chicago—B. L. Steif, Archt., 64 West Randolph St., awarded the contract for the construction of a 6 story, 122 x 137 ft. hotel at 6400-12 Cottage Grove Ave. to F. A. Siebold, Jr., 3136 Sheffield St. Estimated cost $500,000. Owner's name withheld. Steam heating system will be installed.

Ill., Chicago—The Yates Bldg., Corp., c/o Leichenko & Esser, Archts., 38 South Dearborn St., awarded the contract for the construction of a 4 story, 200 x 250 ft. building on Yates St. near 72nd St. to Nelson & Lind, 640 South State St. Estimated cost $600,000. Steam heating and refrigeration systems will be installed.

Ill., Shelbyville—The city awarded contracts for new electric light plant as follows: 150 and 250 kw. turbines to the Westinghouse Mfg. Co., 12th and Gratiot Sts., St. Louis, $19,800; switchboard, station wiring, etc., to the McGraw Co., 2018 Locust St., St. Louis; line supplies to Nixon & Keeley, 2100 State St., East St. Louis, $6,609; brick smokestack, machinery foundations, etc., coal bunker and conveyors to the Erie City Iron Wks., Erie, Pa., $3,950, $2,782 and $5,800 respectively; two 214 hp. boilers and equipment to T. B. Smith, Decatur, Ill., $13,800; building $12,800; miscellaneous contracts $18,000. Noted Nov. 28.

Ia., Clarinda—Swift & Co., 76 West Monroe St., Chicago H. Gilmore Mgr. awarded the contract for the construction of a 4 story, 76 x 164 ft. cold storage plant, here, to Collins Bros., 1600 Grand Ave., Kansas City, Mo. Estimated cost $135,000. Noted Jan. 2.

Kan., Alma—The city awarded the contract for the construction of waterworks system, including one 125 g.p.m. extended water end triplex pump and motor; also for sewage system, including disposal plant, to the C. J. McCoy Constr. Co., Emporia, $30,336 and $34,907.49 respectively. Noted Jan. 30.

Kan., Pittsburg—The city awarded the contract for the construction of intercepting sewers, sewage pumping station and disposal plant to the Beeson Mchy. Co., 308 Mutual Bldg., Kansas City, Mo. Estimated cost $98,800.68. Noted Jan. 30.

Ky., Owensboro — The Owensboro Hotel Co. awarded the contract for the construction of a 5 story, 84 x 184 ft. hotel to the M. J. Hoffman Constr. Co., Furniture Bldg., Evansville, Ind. Estimated cost $450,000. Equipment detail not reported.

Mich., Bay City—W. H. Reid, City Mgr., City Hall, will receive bids until March 12, for furnishing and installing filter plant equipment for water filtration plant, heating, electric lighting systems and power wiring for pumping station and filtration plant, two 10 m.g.d. steam turbo-centrifugal pumps, with condenser and auxiliaries and one 5 m.g.d. motor driven centrifugal pump; high and low pressure steam and water piping, including boiler feed pumps, feed water heater and all accessories in pumping station.

Minn., Duluth—The Russell Miller Milling Co., 25th Ave. S. E. and Marshall St., Minneapolis, awarded the contract for the construction of a 6 story, 275 x 400 ft. grain elevator, electrically operated with 2,000,000 storage capacity, to the Barnett & Record Co., 418 Lyceum Bldg., Duluth, $975,000. Owner will purchase all machinery.

Miss., Moss Point—The Southern Paper Mills, Inc., c/o G. F. Hardy, 309 Bway., New York, awarded the contract for the construction of a 1 to 5 story, 75 x 800 ft. group building, including addition to power plant and sprinkler system, here, to G. J. Glover, Whitney Bldg., New Orleans, La. Estimated cost $1,000,000.

N. Y., Jamestown — The Bd. Educ. awarded the contract for the construction of a Junior High School on Front St. to the Warren Constr. Co., Gokey Bldg., Jamestown, $246,900; heating and ventilating to French & Keith, Randolph, $42,091.

Okla., Guthrie—The city awarded the contract for the construction of extensions to present water works system, pumping equipment consisting of 1,500 g.p.m. Sterling marine engine directly connected to centrifugal pump; sanitary sewer extensions, gravity flow, to the Municipal Excavator Co., 200 East Main St., Oklahoma City, $15,972 and $17,419.12 respectively.

Tex., Quanah—The city awarded the contract for the construction of a 6 mi. pipe line and 500,000 gal. reservoir to the Janes Constr. Co., S. W. Life Bldg., Dallas, approximately $60,000; two pumping stations to L. Martin, Quanah, approximately $4,000.

Wis., Kenosha—The A. Allen Co., 1000 Prairie Ave., awarded the contract for the construction of a 5 story, 90 x 150 ft. factory for the manufacture of hosiery and underwar, to W. W. Oeflein, 86 Michigan St., Milwaukee. Estimated cost $280,000. The owner is in the market for textile machinery and motors.